

April 6, 1959

Aviation Week

Including Space Technology

75 Cents

A McGraw-Hill Publication

Inertial Guidance
System Sales
Show Fast Climb



Modified USAF X-17 Missile
Launches Argus Experiment

ELEGANCE



Convair 880 and 600 Jet-liners YEARS AHEAD FOR YEARS TO COME

The elegance of Convair's 880 and 600 Jet-liners will set standards for luxury travel in the new jet age. Foremost in designing for jet-level comfort, Convair Kosma Engineering experts have succeeded in creating new concepts in color, lighting, and interior appointments. Every modern convenience, comfort, and luxury will be yours in Convair Jet-Liners—truly pleasure that is years ahead for years to come!



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VICKERS®

miniaturized motorpumps ...for Vanguard Earth Satellite Rocket Vehicle

Numerous Vickers miniaturized hydraulic automotive components have been successfully developed for missile use without sacrifice of their inherent high efficiency and reliability. Representative of the "packaged" approach to dependable missile hydraulic power is the PFM-3904 constant displacement piston-type pump shown here mounted on an electric motor. The pump has a theoretical delivery of 0.84 gpm at 7,600 rpm and 1000 psi with a volumetric efficiency of 93%. The explosion proof motor has 6.0 ft-lb torque from 6,000 to 9,000 rpm. The complete package weighs 8.8 lbs., . . . 1 lb. for the hydraulic pump and 7.8 lbs. for the electric motor. The overall length is less than 10 inches. For further information about Vickers miniaturized hydraulic components and complete packages, look for Bulletin A-5216.



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Equipped with an elevation-stepper type mount designed and fabricated in cooperation with M. J. T. Lincoln Laboratory, the big dish can make a full 360° horizontal sweep and has a vertical rotatory capability of 90°. Like all Kennedy parabolic antennas, it features a light weight, aluminum dish supported by a steel pedestal mounted on a concrete base.

This kind of antenna is unique in antenna design and construction. It is a good idea that Kennedy is the name to remember when you are faced with antenna problems.



D. S. KENNEDY & CO.
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Down-Linkable **SOLUTIONS** to
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Tracking Antennas
Radio Telemetry
Radar Antennas
"Trans-Horizon" Antennas
Resonant Reflector
Telescopically Collapsible

AVIATION CALENDAR

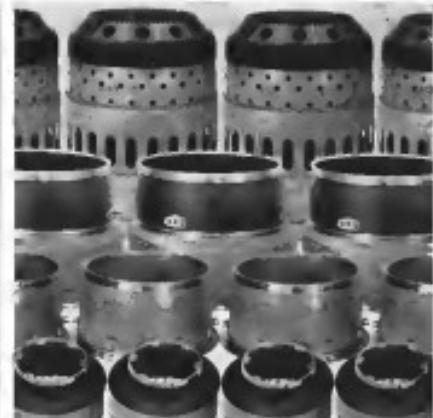
- Apr. 10-Fifth Annual Lester D. Caudle Lecture on the History of Aviation, to be delivered by Conner Loring, Historian, Institute of Technology, Cambridge, Mass.
- Apr. 12-19-Fourth Annual World Congress of Flight, Las Vegas, Nev.
- Apr. 15-17-Second Annual Symposium on Information and Decision Processes, Princeton University, Princeton, N.J.
- Apr. 16-17-7th Annual Meeting, American Training Society, Denver, Colo., Los Angeles, Calif.
- Apr. 16-18-13th Annual Broadcasters' Institute of Radio Engineers' Conference and Electronics Show, Dallas Memorial Auditorium, Dallas, Tex.
- Apr. 20-21-4th Annual State on Circuit Development at Research Administration, American University, Washington, D. C. Sponsored School of Government and Public Affairs.
- Apr. 21-22-Sixth Technical Conference on Electronic Components and Circuits, Section of the Institute of Radio Engineers, Telecommunications Society Edg., Cincinnati, Ohio.
- Apr. 21-23-Ninth Annual Convention, International Airship Association, Cornell Hotel, Manhattan, New York, N.Y.
- Apr. 22-24-1919 Annual Meeting, Institute of Electrical and Electronics Engineers, Columbus Hall, Chicago, Ill.
- Apr. 25-Anual Easter Regional Meeting, Institute of Navigation, Friendship International Airport, Bethesda, Md.
- Apr. 25-26-Quarterly Regional Meeting, American Astronautical Society, Wright-Patterson Air Force Base, Dayton, Ohio.
- Apr. 27-29-11th Annual Meeting, American Medical Association, Statler Hilton Hotel, Los Angeles, Calif.
- Apr. 29-May 2-First National Metal Engineering Conference, American Society of

[Continued on page 6]

AVIATION WEEK including Space Technology

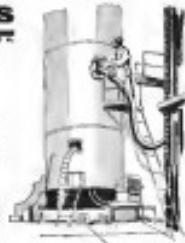
April 6, 1959
Vol. 75, No. 14

Editorial	10
News	12
Space	14
Technology	16
Business	18
Books	20
Advertisers' Index	21
Classified Advertising	22
Letters to the Editors	23
Obituaries	24
Advertisers' Index	25
Advertisers' Index	26
Advertisers' Index	27
Advertisers' Index	28
Advertisers' Index	29
Advertisers' Index	30
Advertisers' Index	31
Advertisers' Index	32
Advertisers' Index	33
Advertisers' Index	34
Advertisers' Index	35
Advertisers' Index	36
Advertisers' Index	37
Advertisers' Index	38
Advertisers' Index	39
Advertisers' Index	40
Advertisers' Index	41
Advertisers' Index	42
Advertisers' Index	43
Advertisers' Index	44
Advertisers' Index	45
Advertisers' Index	46
Advertisers' Index	47
Advertisers' Index	48
Advertisers' Index	49
Advertisers' Index	50
Advertisers' Index	51
Advertisers' Index	52
Advertisers' Index	53
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Advertisers' Index	69
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Advertisers' Index	90
Advertisers' Index	91
Advertisers' Index	92
Advertisers' Index	93
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Advertisers' Index	103
Advertisers' Index	104
Advertisers' Index	105
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Advertisers' Index	108
Advertisers' Index	109
Advertisers' Index	110
Advertisers' Index	111
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Advertisers' Index	478
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Advertisers' Index	481
Advertisers' Index	482
Advertisers' Index	483
Advertisers' Index	484
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Advertisers' Index	490
Advertisers' Index	491
Advertisers' Index	492
Advertisers' Index	493
Advertisers' Index	494
Advertisers' Index	495
Advertisers' Index	496
Advertisers' Index	497
Advertisers' Index	498
Advertisers' Index	499
Advertisers' Index	500



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TRANS-SONICS**QUARTECTOR®****LIQUID LEVEL
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Quarrektor systems and instruments are designed for both liquid applications such as fuel tanks in missiles or other types of pressure vessels, and for gassing applications. A solid-state indication is provided when the liquid has reached pre-selected points in pipe lines or tanks.

The Quarrektor sensing element is a piezo-electric quartz crystal mounted on a probe or submersible sensor unit. Circuitry consists of a four stage trigger stage amplifier with a transistor diode circuit in the feedback loop, and an output control relay. When the crystal is in gas, it is free to vibrate at its natural frequency, and oscillation is sustained. When the crystal is submerged in liquid, however, its motion is damped, signal output drops, and the output control relay de-energizes.

Splashing, bubbles, and surging do not affect the sensor. Liquid induction is given only when the crystal is completely surrounded by liquid. Safety features include a fail-safe and fraction test procedure. Write to Trans-Sonics, Inc., Dept. 7, Burlington, Massachusetts, for Technical Bulletin 1900.

TRANS-SONICS*Precision Transducers*

TRANS-SONICS

AVIATION CALENDAR

(Continued from page 5)

Mathematical Engineers, Head: Sherman Tiv. Park, Allentown, N.Y.
Apr. 18-19—3rd Co-Operative Satellite Conference, American Rocket Society, Massachussetts Institute of Technology, Cambridge, Mass.

Apr. 19-21—Industrial Armed Meeting, Jacobs Electronics Area, McMurtry Hotel, Miami, Fla.

May 3-5—Symposium on Electrode Vacuum Pumps, Florida Institute of Technology/Chemical Division and Electromechanics of Society of Industrial Electronics, Hotel Statler, 1000 Broadway, New York City.

May 4-6—National Aerospace Electronics Conference, Institute of Radio Engineers, Institute Hotel, Dallas, Okla.

May 4-7—Fifth Annual Flight Test Instrumentation Symposium, sponsored by the Instrument Division of American Institute of Service, Olympia Hotel, Seattle, Wash.

May 10—Annual Meeting, California Area of Space Engineers, San Mateo Hotel, San Mateo, Calif.

May 14-15—Electronic Components Conference, Hotel De Paris, Ft. Lauderdale, Fla.

May 14-16—Annual National Forum, Engineers' Homecoming Society, Sheraton Park Hotel, Washington, D.C.

May 14-16—Annual Meeting, National Inter-collegiate Flying Area, University of Illinois, Urbana-Champaign, Ill.

May 17-19—19th Annual Meeting, Society of Aircraft Methods and Precise Equipment Engineers, Dorval, Head Station, New York, N.Y.

May 18-20—11th Annual National Confer-ence, Society of Automotive Engineers, Hotel Henry Clay, Atlanta, Ga.

May 20-22—Annual Meeting, Society for Experimental Stress Analysis, Sheraton Park Hotel, Washington, D.C.

May 21-23—Second Int'l. Airport Confer-ence, American Society of Civil Engineers, Hotel Roosevelt, New York, N.Y.

May 21-23—1970 Cleveland Instrument and Automation Exhibit and Symposium, Cincinnati Section, Instrument Society of America, Music Hall, Cincinnati, Ohio.

May 24-June 1—Federation Internationale d'Aeronautique Aeronautical Meeting, Moscow, USSR.

May 25-27—1970 National Teleconferencing Conference on Investigation of Space, Space Policy and Complementary Areas, Eastgate, East Spokane, American Rocket Society, American Institute of the Astronautical Sciences, American Institute of Electrical Engineers and Astronautical Society of America.

May 26-28—September Thruway Meeting, San Diego Section, Institute of the Aerospace Sciences, San Diego, Calif.

June 1-3—1970 Meeting of the American Association for the Advancement of Science, 10 Carter Hotel, San Diego, Calif.

June 12-13—2nd French International Air Show Le Bourget, Paris, France.

Aug. 18-Sept. 5-10th Annual Congress, International Astronautical Federation, Clark House, Washington, D.C.

Sept. 7-11—1970 Farnborough Fly-in, Display and Exhibitions, Society of British Aircraft Constructors, Farnborough, Eng.

Space Technology Laboratories is responsible for the overall systems engineering, technical direction and related research for the Air Force Intercontinental and Intermediate Range Ballistic Missile Programs and for the highly successful Thor-Able series of short range re-entry launches. In addition, STA carries out special experimental projects for such agencies as the National Aeronautics and Space Administration and the Advanced Research Projects Agency. On behalf of these agencies and in conjunction with the Air Force Ballistic Missile Division, STA designed and produced the Pioneer I payload, one of the most sophisticated fact-finding devices ever launched into space. In addition, STA provided systems engineering and technical direction for the Air Force satellite, the Astro 2000. In support of these and future requirements, STA's activities provide a medium through which scientists and engineers are able to direct their talents and abilities towards the solution of complex space age problems. STA invites inquiries regarding staff openings in any of the five major areas of the company's activities.

Electronics Laboratory

... performs studies/direction for test methods, statistical testing to design and specification of advanced guidance, control, and communication systems; also packaging, environmental testing and over-all checks.

**Aerothermodynamics Laboratory**

... performs basic research including simulation and experimental investigation in magnetohydrodynamics, thermochemical energy transfer, plasma physics, and low temperature orbit state physics.

**Computational & Data Reduction Center**

... provides a REMINUTER mathematical and computing facility and services in advanced research in data systems, information theory, computational systems and automatic programming, systems and instrumentation, and applied mathematics.

**Systems Engineering Division**

... has the overall responsibility for the systems integration of the Atlas, Titan, Thor and Minuteman systems, in addition to responsibility for technical direction of the ultramodern, air-transport, mobility and fixed, and mobile support activities, strategic prepared defense weapons and space systems.



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Most recent development is the wing flap control system for the Convair 880 jetliner. Western Gear carried the entire completely integrated system through design, tooling and fabrication, delivering the units shown here as well as torque tubes, driveshafts, motors and other components.

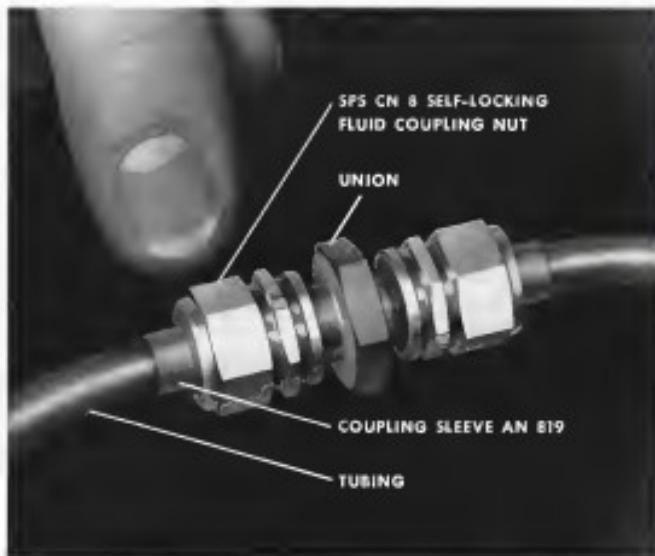
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PROGRESS



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Electro Instruments, Inc.

14

Master Flight Reference

New General Electric Master Flight Reference System integrates direction and attitude changes; guides supersonic aircraft through intricate maneuvers such as over-the-shoulder and toss bombing

A new navigation subsystem, designed to help solve the problem of accurately tracking the various elements of flight emitted at supersonic speeds, has been developed by the General Electric Instrument Department. Designated the SR-1 Master Flight Reference System, this electronic "brain" is already being used to guide some of our fastest jet aircraft maneuvering such as over-the-shoulder and low-level flying, formation turns, and roll-on-roofs.

Initially a direction and altitude reference subsystem, the General Electric SR-1 (Navy designation AN/ASN-26) separates sensor roll, pitch, and yaw change signals by means of three single-axis gyros. These change signals are then converted into multiple signals and subsequently relayed to aircraft radar, autopilot, dead-reckoning, and assignment computers, horizontal stabilizer, and all attitude indicators.

General Electric engineers have designed the Master Flight Reference System around six basic components:

1. A three gyro, four-gearbox, attitude-stable platform from which flight reference information is transmitted.

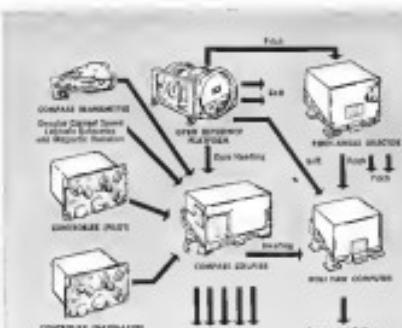
3. A small remote compass transmitter which furnishes an accurate bearing signal and is used in conjunction

The signal sent to each of the platforms with the directionary gyro platform to provide a stabilized heading direction. 3. A coupling device which receives the attitude signal from the platform, plus any necessary correcting signals from the pilot, Doppler radar and the

magnetic compass combining them to provide an accurate azimuth signal with sufficient outputs for the operation of the system.

4. A written permit issued to the pilot's companion for his use in setting up necessary information concerning mode of operation, aircraft, ground speed, altitude, and synchronization of directional gyro and compass. An authorized control panel may be installed for a companion if required.

↳ Answer adapter for platform-specific



output which repeats photomagnetic signals for other wavelet components

measuring attitude information and capable of initiating the operation of any given function at a preset pitch angle. 6 A servo circuit which measures aircraft coordinates to ground coordinates during speed maneuvers. It also provides the aircraft roll information for the autopilot and alternate autopilot.

The Master Flight Reference System is just one of General Electric's many contributions to aircraft instrumentation. Other GE aircraft instruments are used in systems that measure and evaluate such basic flight factors as speed, engine power, altitude, temperature, and position. For information on any of these instrument systems, contact your nearest General Electric Apparatus Sales Office, or write direct to General Electric Co., Section 388-502, Schenectady 4, New York.

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If you would like to work on Interpreting analysis and on the Master Flight Reference System, there may be an unusual opportunity for you with the General Electric Instrument Department. For complete details, write or phone for an appointment with

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GENERAL  ELECTRIC

This is the eighteenth of a series of publications dealing with basic facts about alloy steel. Though much of the information is elementary, we believe it will be of interest to many in other fields—including users of broad experience who may find it useful to review fundamentals from time to time.

Methods of Carburizing Alloy Steels

Carburizing is a means of impregnating the surface of steel with carbon, usually to very limited depths. Its purpose is to provide a hard, wear-resistant "case," or outer shell. Alloy steels, correctly handled, can be case-hardened without sacrificing desirable core properties.

There are three types of carburizing in general use:

Liquid Carburizing—The medium here is a hot salt bath composed basically of cyanide compounds. The steel is immersed in the bath, the period of immersion depending upon the analysis of the steel and the depth of case desired. Liquid carburizing is a convenient method of producing thin, hard, wear-resistant cases, generally within the depth range of 0.02 to 0.05 in. However, deeper cases may be obtained, the actual depths depending upon economics and end uses.

Gas Carburizing—This method employs a furnace in which a carbonaceous atmosphere is created; i.e., gases that are high in carbon compounds, or those containing carbon. Steel subjected to gas carburizing can be case-hardened to depths generally ranging from 0.01 to 0.04 in. When quenching takes

place immediately after carburizing, distortion can be kept to a minimum.

Pack Carburizing—Where the pack method is used, the parts to be carburized are buried in a container of dry carbonaceous materials. The container is sealed tight to prevent the infiltration of air, placed in a furnace and kept there for eight hours or more, the actual time depending upon the depth of case desired. Pack carburizing is particularly suitable where a deep case is essential (0.06 in. and over), although surface cases in the 0.04-to-0.05-in. range are possible.

The carburizing of alloy steels is a highly technical subject, and Bethlehem metallurgists will be glad to help you with any phase of it. Feel free to consult with them about the results to be expected from various analyses and the various methods of treatment. And when you are in the market for alloy steels of any kind, please bear in mind that Bethlehem Steel makes the complete range of AISI standard grades of alloy steels, as well as special-analysis steels and all carbon grades.

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including Space Technology

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EDITORIAL

Business Flying's Future

One of the brighter spots in the entire aviation spectrum is the current growth and future prospect of the wide variety of flight operations located under the general classification of business flying. The solid expansion in this area during the past few years has proved that post-war propeller aircraft covering this subject were right for the wrong reasons. Post-war private flying did not, even although neither of the time nor in the manner so wished, experience 15 years ago.

This growth did not begin its significant surge in 1946 on the crest of returning war veterans anxious to buy a low-priced "flower child." In fact, instead of a second automobile, instead of the ownership of the light two-passenger automobile with a sales tag ranging from \$12,000 up, its purchase entitlements have been business men—teachers, dentists, oil operators, doctors, etc., who have an enormous need for reliable vehicles for transportation.

Percent Status

The present status of business flying was well detailed by Erwin J. Bellon, AVIATION WITH BUSINESS FLYING, chapter 1, on May 9 issue (p. 249). The conclusions located there are truly astonishing and worth repeating. A total of 6,416 new private planes sold during 1955 for a retail billing of over \$135 million-plus—just about four times the number of only two years ago. Business planes logged 5.5 million hours in the air during 1955. This represents a growth of 350% in the past decade, accounts for about 85% of all time in the air and in 1.5 million more hours than the scheduled volume of the U.S. AAs in the same year. In addition, the volume of fixed base operations serving this field now is running at about \$800 million annually.

All of this has been achieved by some radical departures from present marketing as virtually every segment of the business—from technical design to financing and sales. The manufacturers have made a good start in building solid sales techniques to fit a more atomic and atomistically simple for large segments of the American people in their own planes. They are producing dealers and mechanics with better sales tools and guidance, removing mystery of the automobile industry's proven techniques for calculating sales, and recognizing the need for tightening standards for its dealers, including attractive quarters, adequate number of demonstration planes, fine service, sound service features and financial responsibility. They have also developed more modern financing methods for both customers and dealers with one establishment's financial subsidiary boasting over \$1 million worth of new aircraft sales since 1953 and over \$36 million worth in organization only. These are just

dollar in the next five years. Instruction flying, which was lagging badly only a few years ago, is catching up as the growth curve has increased from 1.5 percent annually in 1957 to 1.9 million hours for last year. The annual fixed base operations bill will probably double to a billion dollar annual rate by 1962 and close to \$300 million will be spent on research and development for improved performance aircraft for the business flying field.

FAQ Recognition

We have also noted a growing recognition of the importance of that area by the new Federal Aviation Agency. The FAA will handle the business flag field but has been interested and broken down into special areas for each of its various segments. The FAA is proceeding to fly in its National Aviation Facilities Experimental Center at Atlantic City scheduled for May 9 another indication that this agency plans to devote proper manpower in this area. We also note that the Air Force is promoting private flying. For example, Strategic Air Command now has private flag clubs at 17 airfields with a total membership of 3,000 military and civilian personnel. The flag club at SAC headquarters area has 17 civil planes and expects to log \$300,000 for this year.

Nor is business being actively concentrated solely in the wide open spaces of Texas and California, although these areas offer some of the greatest economic soil for possible growth. In the heavy traffic density of the New York terminal area, LaGuardia Field recorded 30,516 persons and corporate aircraft movements in 1959. Newark totalled 23,316 and Idlewild 18,586. All of this was in addition to the 91,005 recorded at Teterboro which is designated as the major center for this type traffic in the New York area.

Growth Policy Problems

This continued growth of biomass flying ports on patient problems for all elements concerned—passenger, federal agencies, pilots and owners. As the bus and small aircraft gain greater utility and performance, pilot standards must be improved consequently. Proactively with new airworthiness and flight control instruments will become a necessity, instead of a professional hazard. Fixed base operators must provide better facilities to handle the increasing and maintenance of the growing private aircraft fleet. Manufacturers must provide more thorough, expanding, mishaps, performance and maintenance in place damage. And the government groups concerned with safety regulations, support construction and financing, design and operation of airports and traffic

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WHO'S WHERE

In the Front Office

Charles A. Ellement, board chairman, and George Clegg, National Sales Mgr., International Business, are president and chairman of the board of the American Airlines Inc.

J. A. R. Key succeeds Sir Roy Disney as managing director of A. Y. Roy and Co. Ltd., subsidiary of the Rank Brothers Group Ltd., London, England. S. G. Jelley succeeds Mr. Key as general manager of A. Y. Roy. Other members of the Rank Brothers' executive group, Sir Roy will continue on activities of the studio group.

Donald A. McRitchie, president, Atlanta World Corp., Cleveland, Ohio.

Dr. John T. Baldwin, executive vice president, Defense Electronics, Inc., Dallas.

N. E. Shaffer, executive vice president, Schenckers-Hill Inc., Hawthorne, Calif.

Manus H. Myers, vice president, research, development and registration, Link Aviation, Inc., Birmingham, N.Y.

Jak F. Lipe, vice president, industrial and special programs, Raven Instrument Corp., subsidiaries of Dynamics Corp. of America, Gladwin, Pa., N.Y.

S. E. Tamm, vice president, engineering, Republic Manufacturing Co., Cleveland.

Donald H. Mihailo, vice president, Consumer Division of American Machine & Metal, Inc., head of the newly formed Auto-Access Division.

Stephen B. Higgins and Thomas M. Nolin, member vice presidents, Bell Aircraft Corp., Buffalo, N.Y. Mr. Higgins is sales manager and Mr. Nolin sales vice president of Bell's aircraft division.

Dr. George P. Kotsopoulos of Harvard University has been named to the staff director of United Research Corp., Model Prod., Calif., subsidiary of United Aircraft Corp.

Alphonso H. Flin, vice president technical director, Cornell Instrument Laboratory, Inc., Buffalo, N.Y.

Honors and Elections

Meriel Bennett, French aircraft designer, has received The Royal Astronomical Society's Gold Medal for outstanding contribution to the design and development of aircraft.

William Loveland, American Airlines vice president equipment development, has been appointed chairman of the National Aerospace and Space Administration's Research Advisory Committee on Aircraft Operating Problems.

Changes

Dr. Adolph S. Thiel, program director for space mission system technology, Laboratories for Los Angeles, Calif. Dr. Thiel was formerly director of VTR's Space Program Office. Walter A. Brem, formerly vice president, Advanced Systems and Test Department, Astro-Fugro, Inc., has joined the company as Vice President and Test Department Manager.

Dr. Alton H. Ryan, manager, General Electric's Marquette Laboratories, Peoria, Ill., will

INDUSTRY OBSERVER

► Rock Corp. of America has proposed a novel telescoping configuration for an extended ballistic missile which can be carried by railroads. In the North American S-70 in Air Force's S-110 competition. Proposed brings the total number of boosters in the configuration to 14. Rock's proposal calls for a hybrid guidance system using inertial elements but one which can be more easily tested and corrected in flight.

► Air Force's Dyna-Soar simulation flight as experimental orbital weapon system in an explosive prototype test vehicle excludes elimination of the engine. Vehicle now will be an augmented glider, boosted to near satellite speeds and altitude.

► Rough timetable for the availability of new engines under National Aero and Space Administration's orbital space rocket program is mid-1960 for the 6,000-lb thrust solid rocket being developed at Jet Propulsion Laboratory first month or so of 1965 for the 13,000-lb thrust liquid oxygen-hydrogen engine being developed at Pratt & Whitney, which will be coupled to form a double-barreled second stage for the Centaur vehicle; first quarter of 1965 for the 30,000-lb thrust liquid oxygen-hydrogen engine, under study; mid-1965 for the second 20,000-lb thrust flexible engine under study; end of 1965 for the 1-Ton-thrust liquid oxygen-chamber engine under development at Rocketdyne.

► Next Army satellite will combine four experiments originally scheduled for Vanguard project but left without launching vehicles due to management changes. Army satellite also will carry a few silicon solar cells instead of quartz windows currently used to protect against micrometeorites to determine if the cells can operate satisfactorily without heavy shielding which reduce the amount of electric power generated.

► One current of Navy's Communications Mean Relay is scheduled to go into operation this fall linking Washington with Pearl Harbor. Station uses the seven in a passive ring. It is now in test and evaluation stage and is expected to provide greater reliability and intruding capabilities.

► Polaris fleet ballistic missile launching centers are to be installed aboard the Long Beach, Navy's first unguided-projectile guided-missile cruiser. Funds for Polaris installation on this and other surface ships may be included in the fiscal 1961 budget requests depending partly upon results of launching tests since the surface war ship Observatory Island.

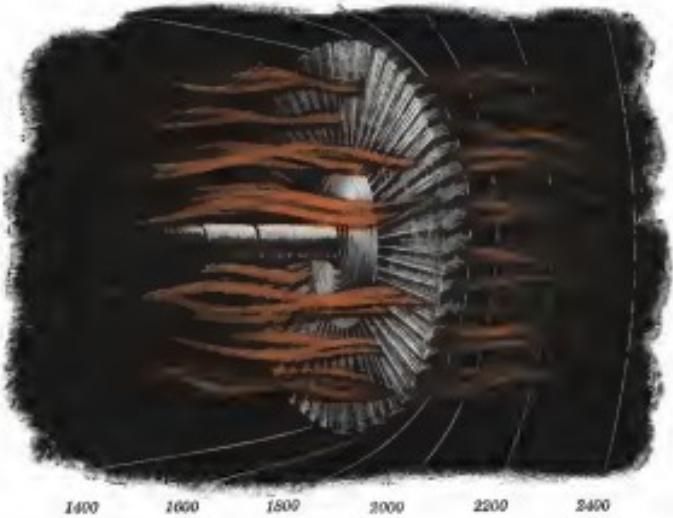
► Despite a delay in Polaris unit firing, Navy considers that the first fleet full scale flight test vehicles have demonstrated flight acceptability of the solid propellant and of the flight separation system. Twenty-one of the 25 flight test vehicles that had been fired up to the beginning of this year were considered unsatisfactory. Failure in the first six no full scale flights were reported due to elements that will not become part of the operational missile. First failure involved the detent system, the second a flight program. Grace of the third failure is undetermined. Current data in trials at a high to high temperature problem that are affecting the directional control system.

► Navy's ASROC ship-based missile anti-submarine system is expected to be ready for service test as early fiscal 1960.

► Air Force F-106 aircraft procurement program includes 78 Boeing F-102A bombers, B-57H is an improved-range version of the B-57 to be purchased by Pratt & Whitney's St. Louis division. Air Force also plans to buy 96 Boeing KC-135 jet tankers during the year.

► Army plans to purchase areas in Shreveport, Corbeau sheet metal and landing strip areas in fiscal 1969 for operational and organizational tests. If Army buys the Corbeau in quantity, the aircraft will be employed in the initial transport component of 16 planes each with one company assigned to each Army and each Army corps.

{Continued on page 125}



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Washington Roundup

Nuclear-Plane Query

Rep. Melvin Price (D-Ill.) chairman of the research and development subcommittee of the joint Congressional Atomic Energy Committee and an ardent proponent for pushing ahead with the U.S. underground plutonium program, is planning an inspection tour of the General Electric nuclear weapons plant at Eunice, Okla., in an effort to find out just how soon the country could put an nuclear plane into the air. Defense Dept. sources who are reported to be participating in delegations headed by Deputy Secretary Donald Quarles, a long-time advocate of the "go-slow" approach,

- To inquire the Recognition Board to give "due care attention" to the pricing provisions of executive-type contracts. A major complaint of aircraft companies is that the Recognition Board makes executive-type contracts unnecessary by incorporating some savings.
- To inquire Recognition Board in its determination to specifically before the contractor as to the consideration and recognition it has given to each of the numerous factors listed in the low-consideration of costs and profits with regard to volume of production, private equity investment, extent of risk, insurance and developmental contributions, etc.

In Congress

Other Capitol Hill developments include:

- Weapons systems. House Armed Services Investigating Subcommittee, headed by Rep. Edward Hadas (D-La.) will begin an evaluation of weapon system procurement on April 13 with testimony from J. L. Award, president of North American Aviation, Inc. Award will be followed by Comairtech Corp., president of Lockheed Scientific Corp.

• Missile management. House Military Operations Subcommittee, headed by Rep. Chet Hollings (D-Calf.) has concluded hearings with missile contractors originally scheduled to begin today, and is proceeding to write a report weighing Army's "missile" management against that of the Air Force (AWW Mar. 23, p. 3). The subcommittee staff has interviewed several contractors, including Convair, Lockheed Aircraft Corp., Armed Forces General, and the Rockwell-Douglas Division of North American Aircraft.

• MATS. The House subcommittee also is scheduling a hearing on MATS Air Transport Service for the first week of May. The subcommittee has contacted MATS for developing services comparable with commercial operators.

• Federal Aviation Agency. House Information Subcom. headed by Rep. John Yon (D-Calif.) is investigating charges that Federal Aviation Agency has imposed rigorous restrictions on deliveries in connection with the new type aircraft installed at Lockheed Electra refurbishing and Boeing 707-120 jet transports.

• Presidential fighters. Senate Armed Services Committee is expected to release a memorandum shortly to congressional leaders concerning the two F-15s and B-1s that are making extensive changes in procurement laws aimed at cutting cost. This is a new military weapons development (AWW Aug. 10, p. 38).

New Cargo Plane

Meanwhile, Air Transport Area officials and technicians plan sessions with members of the Strategic Commerce Committee later this month to discuss Sen. Mike Mansfield's (D-Mt.) proposal for a \$3 billion investment for a fleet of 100 efficient cargo aircraft for military supply and commercial purposes. Mansfield, chairman of the Armed Services Subcommittee, is trying to profit the public. Mansfield suggests that 100 of these aircraft go to the Midwest Air Transport Service and 50 to commercial carriers in the southeast for military airlift on a 24-hour notice.

Renegotiation Hearings

House Ways and Means Committee will start hearings on extension of the Renegotiation Act on April 27 with participation of Renegotiation Board and Defense Dept. officials. In a letter to congressional chairman Rep. Walter Mathis (D-Ala.), Defense Secretary James Doolittle said Defense wants:

- To extend the law for two years and three months from the present expiration date of June 30, 1959, to Sept. 30, 1961.
- In the rapidly advancing aircraft, missile and space fields, Quaker says, there was past production and cost comparison to assist update contract profits. Quaker has shown that the renegotiation software is effective itself.

- To sustain the appeal of renegotiation rulings of the U.S. Tax Court to the Court of Appeals. Aircraft manufacturers urged this last year.

Navigation Dispute Lingers

Despite International Civil Aviation Organization decision to adopt VOR-DME-T as the international standard, which is preferred by the British, Congress would sponsored House action (AWW Mar. 2, p. 24). The British can be expected to make a strong battle front of this. The continental map was placed on the agenda following last month's meeting here between President Eisenhower and Prime Minister Harold Macmillan but not later discussed in the recommendation of the Federal Aviation Agency. FAA Administrator Edward Quisenberry, who has traveled two trips to England in the past six months—including the November trip with Vice President Nixon—is now definitely planning to visit Britain within the next future. —Washington staff

Sun May Be Origin of Van Allen Radiation

U. S. lunar probe detects new intensity in belts; data indicates inner layer particles are protons.

By Evert Clark

Washington—Pioneer IV lunar probe, launched after five days of intense solar activity, has shown "almost certainly" that the sun is the origin of the charged particles trapped in the outermost Van Allen layer by the earth's magnetic field.

The probe detected radiation 2 to 10 hours at intervals at that measured by Pioneer III and found the peak of intensity to be 10,000 to 15,000 electron units from the earth than the peak measured three months earlier by Pioneer III.

Origin of the particles in the outer Van Allen layer is still in dispute but "a very ingenious part nucleus analysis" of the findings of the探月四号卫星的飞行 by the Van Allen group has led to the conclusion that the energetic particles in the outer layer definitely are protons.

There, and a number of other details concerning the two belts of particles spiraling along the magnetic field of the earth that surround the earth, were disclosed following a Sunday seminar sponsored by the National Aerospace and Space Administration's Technical Division. Fermilab participants or the proponents of the radiation belts and their geomagnetic significance will be made at a May National Academy of Sciences/NASA/American Physical Society Symposium here April 27-29.

Other speakers discussed at a press conference that followed the seminar:

- Solar Van Allen belt? of particles trapped by the sun's magnetic field and occasionally exploded toward earth may explain the origin of the particles found in the outer layer was early, according to Prof. Thomas Gold of Harvard University. If the sun can capture the particles of the corona magnetic winds to take the particles to earth the sun would be the source of the velocity of escape that are known that these particles have when they get loose." Gold also believes that "one process similar to conversion processes in the earth's atmosphere might help explain how the outer

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The velocities of the billions (of a particular particle within the layer) depend on altitude, and they stage from around a few hundred kilometers to over 100,000 km at a thousand kilometers." Judd said the estimates go as high as "man" years "allowing us to 10, or something like that." This will be discussed further at the April symposium. Further supported by the Pioneer experiments are certain Japanese, because they were not fed into the belt for long enough," but could do it at other low levels," Prof. Gold said.

• Inner belt's origin may be solar, as Gold and Judd are inclined to believe,

or as a result of the belt theory of acceleration into protons and electrons, as Dr. E. Tad Stogin of Maryland University and Charlottesville are inclined to believe. Christensen and he has not excluded the possibility of "very dense" ions coming from solar particles. Those who advanced the scenario believed that belt density hypothesis could be explained in the same way it is explained by the belt theory.

"Presently we are left with the idea of the two belts needed to make the arguments to be very difficult to understand," Judd said. "In other words, you can understand that there is a large concentration of particles left by the sun, let us say. You can understand that there are particles at lower altitudes left by the sun down to other storms. But you can not say my clear indications understand why one belt is not merged into the other, but why there should be a gap instead." One suggestion was that an irregularity in the magnetic field over South Africa is so located that it might account for the gap between the particles... when they come to the belt over South Africa, drift into it. They descend into somewhat lower altitudes than they would if the field were perfectly uniform. At lower altitudes they merge in and they get taken out of the radiation layer."

• Space vehicle, involving of the tree of an effective solar帆, "might save a great percentage of flux, not only the captured flux in the earth's field, but far more, too," Gold said. This would be the case if the sun's magnetic field is focused near an space beyond the earth and the earth happens to pass through a part of the field, as Gold believes probable. The intensity

USAF Drops XF-109
Washington—Forces have withdrawn the aircraft from the X-37 March 2 at Wright-Patterson Air Force Base, Ohio, where it had been developed by Bell Aircraft Corp. Because of lack of funds, Navy personnel had been forced to withdraw from the program. (AW Mar. 27, 79).

Enter the Air Force, Bell formed with Convair to form a joint venture company management from its probe development of the program (AW Feb. 9, p. 12). The two companies may continue development of the XF-109 with joint corporate funds in hopes of finding a new market for the aircraft. Actual conception of the plane, whose sales designation was X-37A, was published in the Jan. 5 issue of Aviation Week (p. 2).



Sikorsky S-60 Crane Makes First Flight

Sikorsky's S-60 flying crane helicopter made its first flight the day after the United Aircraft Division rolled out the Navy SH-3D nuclear-helicopter (AW Mar. 16, p. 30). Its first week it had logged 5 hr. flight time. The sister version and one Prost & Whitney K350 piston engines are the same as those of the company's S-65 permitting Sikorsky to complete its new program and to fly the S-60 to Ft. Rugg, N. C., later next week for an Army demonstration. The present ship uses a tail wheel landing gear layout. However, the company is being an S-65 fitted with the Navy's twin-boom tail rotor system that would permit using a nose wheel layout, enabling the aircraft to land from the side. The cockpit features a novel rotating seat for the pilot, so that he can face forward in flight or backward in load handling (AW Oct. 2, p. 29). Various turboshaft engines are in consideration with GE T700 or PW F117A frequently mentioned.

detected by a space vehicle might be "at great at the intensity that occurs in here, or even more," and probably would last only a couple of hours. Interpretation of this for assumed solar风 might not be known until more flights are made and the instruments of the instruments are improved. If the interpretation of the magnetic field theory is correct, all effects would be expected to be greater at Venus, which is closer to the sun and is believed to have a magnetic field.

• It is "very possible" that aurora are caused by the ionosphere and "probable" that the Van Allen layer holds the upper atmosphere. "Surprising result" of a better understanding of Pioneer III's data had led off of only a few months, just several years ago, to a major advance in our knowledge of Earth's magnetic field, namely the trapped particles into the auroral regions, apparently causing the aurora.

• The probe also found that the peak intensity shifted outward from the earth's center by 10,000 to 15,000 km to a distance of about 15,000 km. It also found that at a point where Pioneer III's data had leveled off after a few months, just several years ago, to a major advance in our knowledge of Earth's magnetic field, namely the trapped particles into the auroral regions, apparently causing the aurora.

Aurora Probe

Pioneer IV, as NASA-Army lunar probe first last Dec. 6, returned to 116,000 km. Its measurements indicated that the radiation belt actually was two belts. It drifted outward from the center of the earth to 65,000 km. Geiger counters Pioneer IV's flight were about 3,000 to some 36,000 counts per minute at 15,000 km and 25,000 km.

Pioneer IV, launched on Mar. 1

following five days of intense solar and earth activity, found little change in the intensity of the inner zone, but intensity of the outer zone was found to be about 10 times that of Pioneer III's readings by a factor of 10, and the outer region was interpreted as being the Van Allen region.

Several auroras also have been seen as a result of Pioneer's flight that the outer belt definitely contains electrons in its up, or less energetic component.

Van Allen's group also found a penetrating component in the outer belt—so-called electrons of escape grade (some 600,000 eV) or protons with energies of the order of 100 million volts or greater—but they are in lesser numbers than the "soft" electrons.

Inner Belt

In the inner belt, the Van Allen group has determined that the inner, outer, and outermost particles are protons. The outer particles, which are smaller than the hard, are 10,000 km, may be either proton or electron.

Gold, however, that the evidence from Pioneer IV's flight is "very though suggestive, if not as absolute proof," that a solar storm can raise and set the earth's magnetic field, finding that particles are trapped into the magnetic field and are lost when the magnetic field is disturbed.

Interplanetary, a flat magnetic field, the earth disrupts into the general

Blowlamp, Backfin Design Data Detailed

Budapest.—New design details and performance specifications of the Hungarian Blowlamp and the Yakovlev Yak-42 (Backfin), two of the Soviet Union's newest bombers, have been reported here.

The two 1,000-mph class bombers are now in active service, according to the Hungarian magazine *Budapesti Újság*, and are replacing the submarine hydrofoil B-10 which has been produced in quantity. Both bombers are in service for close air support, anti-fascist and anti-Russia operations. Some of the information used in the Hungarian article was described in recently released Russian data.

The Yak-42 Backfin radome bomber has a maximum gross weight of 123,000 lb and a bomb load speed of 950 mph (Mach 1.25) at 40,000 ft, and cruise speed is 680 mph at 42,000 ft. Its 6½-thick wing has a constant planform with a leading edge sweep of 60 deg in the inner panels and 46 deg in the outer.

Propellers on the Backfin are two AM-5 axial flow turbines (NATO Mar 30, p. 101) driving a propwash attack 18,000 ft, thrust each without reverse, times and 22,000 ft with afterburner. The engines are located side by side in

the aft section of the fuselage, and the intakes are well forward on the fuselage just behind the cockpit. They are shoulder type intakes just above the wing which is at a midwing location. The Hungarian source describes the Backfin as the first Soviet aircraft with bullet proof intakes for booster rockets. These solid rocket boosters are an added part of the fuselage just behind the leading edge of the wing.

The Yak-42 is given a range of 1,000

to 3,000 miles in service for close air support, anti-fascist and anti-Russia operations. Some of the information used in the Hungarian article was described in recently released Russian data.

Blowlamp Gross Weight

The B-10 Blowlamp is about half the gross weight of the Backfin, weighing a maximum of 65,000 lb. It also is somewhat slower than the Backfin, with a top speed of 910 mph at 39,100 ft and a cruise speed of 760 mph. Maximum speed at 36,000 ft is given as 725 mph.

Blowlamp is apparently the first operational USSR aircraft with podded engines. Two M-109 engines without afterburners are carried, one under each wing. The wing is swept 90 deg at the leading edge and extended high on the fuselage with pods suspended from

nearly long wings. Each engine develops approximately 13,000 lb. thrust. Each load of the Blowlamp is a maximum of 4,850 lb., and it may be carried internally or externally. Range of the two-place bomber on a combat mission is given as 745 mi. If it approaches the target at better than 40,000 ft, it could spend 35 min in a high altitude orbit above the target on this mission, according to Report. On a 1,000-mile mission, the takeoff at about 3,500 ft with only 15 min of fuel.

Both the Backfin and the Blowlamp are equipped with tail launch racks carrying a 37-mm stabilized weapon. Additional armament aboard the Backfin includes six 325-mm guided rockets for use against ground. The Blowlamp carries 36 guided rockets for attacking air ground targets.

Physical characteristics of the Yak-42 radome bomber include a wing span of 67 ft, length 77 ft, height 25.5 ft, wing area 300 sq ft, aspect ratio of five, chordwise lift coefficient of .05, empty weight of 35,000 lb, fuel weight of 36,300 lb, ferment weight 440 lb, maximum loading weight 74,000 lb, loading speed 135 mph, maximum rate of climb 24,000 fpm, service ceiling 40,000 ft, takeoff run of 6,300 ft, and 49 ft of

climb, landing run of 5,400 ft without breaking gear放出.

The aircraft's full span leading edge slats apparently are large enough to provide as much as wing area when they are extended. The plane also includes a glaucometer, which is similar to the one made to fit on the Tu-104 jet transports, with the leading edge located on the midplane of the fuselage behind the position, and one leading edge flap on each wing span.

Gross complement of the Yak-42 is six and gross weight, but a total crew weight of 6,600 lb was reported. On other Soviet aircraft, about 170 lb is allowed per man for crew weight, but this figure apparently varies slightly with the design. It is probable that the Yak-42 carries three men at a design weight of 220 lb per man, rather than five men at 165 lb each.

Additional planned characteristics of the B-10 Blowlamp include wing span 58.4 ft, length 77 ft, height 25 ft, wing area 300 sq ft, aspect ratio of five, chordwise lift coefficient of .05, empty weight of 25,000 lb, ferment weight 600 lb, loading speed 140 mph, landing run without problems of 4,700 ft, takeoff distance over 60° incline of 10,700 ft, ceiling of 38,000 ft.

Tandem Gear

The Blowlamp has a tandem landing gear that retracts into the fuselage. Two tires are on each wheel. The tandem gear on the Blowlamp is 17 ft 6 in. greater.

The Backfin landing gear is a tricycle type that retracts into the fuselage.

Blowlamp was first publicly displayed at Kirovograd on September 1, 1965. However, in 1966, not long after the Tu-144, the first supersonic transport, was shown (AW, Sept. 7, 1966, p. 26), Tu-144, Blowlamp was spotted during flight tests for the air show but failed to appear in the air on the day of the Ukraine show. It was displayed on the ground at Kubinka for Capt. Nikolai Tsvetkov, then USAF chief of staff, and his staff.

Capt. Tsvetkov strongly insisted he had the House Armed Services Committee that he had no information on what had happened to the Blowlamp program until he saw the prototype and said there was evidence that it had been put into productive or operational use.

Blowlamp was first spotted in the air around Moscow in June, 1967, during rehearsals for the annual Tushino show (AW, Sept. 9, 1967, p. 38). The 1967 show saw some emerged behind the curtain political battle in the Congress of hierarchy that resulted in the emergence of Nikita Khrushchev as the top leader. Analysis Weekly, published in what's sketch of Backfin on [Jan. 28, 1968, p. 39]

New Soviet Submarine, Bomber Reported by Defense Officials

By Fred Eaton

completed by, and now available in other Air Force contracts.

• Soviet Union is clearly ahead of the U.S. in numbers of jets less than the 1,000-m range, and the reason the U.S. has to behind Russia in intercontinental ballistic missile production within two to three years is that the U.S. is slow to catch up with other developments, the Russians produce open 1965.

• Gen. Twining, staff the Joint Chiefs have made 18 costly studies and experiments on the subject and found out of four members of the Joint Chiefs were in agreement that missile capability was adequate as a basis for planning to meet limited and general war situations. Defense apparently uses Army Gen. Maxwell Taylor.

• The U.S. M-20W had, has decided upon a combination of dispersal and hardening of missile sites in protection against destruction during attack. "The way," he said, "of how I see it, the M-20 launching radars had to change sites, perhaps every 10 minutes, against what was all impact on one of the dispersed sites we can have left. That way, he has to have a much greater amount of attack as probably in order to knock us out."

Air Force

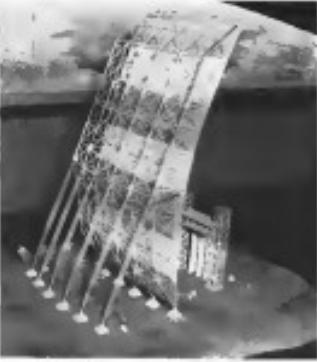
Highlights of Air Force decisions included:

- Aircraft procurement, double—Mrs. Gen. James Dugan, USAF director of requirements, and the Air Force is requesting 54,459.1 million in new obligations authority for fiscal 1968 which will prevent it to carry out its aircraft procurement programs totaling \$4,813.9 million as compared with

Republie Layoff

New York-Republic Aviation Corp will cut 2,369 employees in a result of USAF's decision to change its orders for the F-101C fighter-interceptor fighter to the original configuration. The 1968 budget cutback will affect the company's F-101C production, which will be discontinued in F-101D. Production of the F-101E single-seat day fighter backlog cuts the crew and will be completed by the F-101D.

Lately will be necessary over several months as required in order and certain parts not to storage production schedules for the changed program, according to Moody L. Peck, Republic president. Republic currently employs 17,000 personnel.



BMEWS Antenna Displayed in Model Form

AN/FPS-17 radar antenna, prototype of units being developed for Ballistic Missile Early Warning System (BMEWS) installations in Alaska and Greenland, is shown in model form. Six point antennas, produced by U.S. Scientific & Co., is situated by models of missile base and truck trailer. The FPS-17 radar produced by General Electric, is installed in Turkey to monitor Soviet ballistic missile test range and in Libya, Tex. for tracking ballistic missiles launched from Cape Concord, Fla.

\$1,158 million for Fiscal 1999. Procurement program goals for a total of 704 aircraft, Ferguson said. The program also provides for nearly 100 jet trainers, 10 jet cargo transports and 18 C-130Js, plus 40 additional in Fiscal 1999.

■ **Nuclear-powered cruise missile**—Gen. Ferguson said the Air Force needs a nuclear-powered plane to achieve the endurance needed to give more flexibility in the bomber force and to increase the efficiency of the aircraft fleet operations.

■ **Middle procurement**—Gen. Ferguson told the subcommittee that new oblique launch contracts require \$1 billion in that category today, \$2,681.2 million will finance a program totaling \$2,763.1 million as compared with a Fiscal 1999 program of \$3,050.0 billion. About 51% of the funding provided will be for production and development of the Aegis and T-100 R/Cables and development and testing of the Minuteman, Development, test and evaluation support effort amounts to \$883.2 million.

■ **SAGE programs**—Five facilities of the SAGE early warning system are at an agouti and five more will become operational by mid-1998.

■ **Seven-hour global**—Air Force Secretary James H. Douglass, Jr., told the subcommittee that the Air Force apparently had all but possible than believe he has successfully bombing a long range target that day (See 12, p. 28). He said they also have had failures in satellite launches.

■ **Manned bombers advantages**—Gen. Thomas D. White, Air Force chief of staff, said one advantage of the bomber over the F/A-18C is that it can take triple decker weapons. It also can carry a much longer load and range and it can be refueled, Gen. White pointed out. In addition, he said, it has a greater potential for use in limited war. Because of the low explosive probability rate of the modern jet bomber and the high yield of the weapons which can be carried, only one independently armed anti-aircraft missile is required to score a 90% probability of destroying a point target, Gen. White said.

■ **Navy airborne control**:

■ **Polaris funds for Fiscal 1990**—Navy Secretary Thomas S. Gates, Jr., expressed concern that the Defense Department's requesting \$611,186,000 is still far below congressional intent. Polarized subcommittee Chairman Dennis J. Halligan asked, "What's the reason?"

■ **Contingent air defense**—Gen. Dougall D. Taylor, Army chief of staff, and the head of Fiscal 1998 thus will be 62 surface-to-air missile battalions on site and operational. By the end of fiscal 1998, it will be increased by two battalions to 63. In addition, there will

need communications centers, operation of fire, shape detection and coordination of rapport facilities, and training of personnel.

■ **Surface-to-air missile procurement**—Procurement in Fiscal 1998 will be lower than either of the two previous years, Gen. Taylor said, because of the elimination of the BlueStreak program and the lower level of procurement for ground-based equipment. However, funds for included in Fiscal 1998 to procure Nite Hawk performance against jamming by radio and other electronic countermeasures.

■ **Constitutive of Navy anti-torpedo programs**—Secretary Bunker and the Burt guided systems program was terminated last September in the interests of efficiency and cost.

■ **High altitude programs**—For Binson, Gen. Bunker-Bandler said the project will be completed within the next two years. Improvements will provide higher stability, increased accuracy and longer range in comparison with the currently operational Harpoon joint surface-to-surface missile.

he 10 battalions deployed at overseas bases.

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Backlog Increases At General Dynamics

General Dynamics Corp. reported a backlog of over \$2 billion at the end of 1993, a year in which the corporation recorded sales of \$13.1, \$14.761 and earnings of \$1.279,729,115.

These totals were second only to 1992's record sales of \$13.362, \$18.908 and earnings of \$14.774,763. The 1993 earnings were \$0.469, up 53.7% from 1992, compared with \$4.80 a share the prior year.

Despite the backlog listed, the corporation also lost contract value negotiations at year end totaling \$615 million. The 1993 total of \$2.05 billion compares with \$1.790 billion a year earlier.

Other financial reports

■ **Bell Aerospace Corp.** sales in 1993 dropped to \$152,865,229, compared with \$162,512,514 the year before, but earnings rose from \$4,366,429 to \$4,621 a share in 1993 to \$15,789,789 or \$1.77 a share last year. Contractual sales are counted for 95% of the corporation's net revenue.

■ **Korean Aerospace Corp.** sales rose 5% to \$161,571,574,667 in 1993. Earnings also increased from \$447,732 in 1992 to \$51,017 in 1993.

■ **Fairchild Engine & Airplane Corp.** reported a net loss of \$17,451,764 for 1993 after a \$14,000,000 tax credit previously due to antitrust laws. On its F-22 aircraft program progress, backlog declined from \$176 million to \$113 million. Sales declined from \$118,621, \$112 in 1992 to \$143,016,559 in 1993. The company had earned \$103,331 in 1992.

Space Technology

Argus Potential as Weapon Described

By Fred Eastman

Washington—Total air blockade of radio and radio communications could be produced from high altitude nuclear blasts similar to the Project Argus tests of last August and September (AVW, May 23, 1993, p. 25, Mar. 9, 1994, p. 26) in order to disrupt the communications capability of an adversary, according to Dr. Ray W. Johnson, director of Defense Department's Advanced Research Projects Agency.

Testifying before the Senate Subcommittee on Government Operations for Space Aviation, Johnson said Project Argus tests indicated that strategically placed high-altitude nuclear blasts could result in total blackouts of radio and radio in certain areas. As an example, he said the explosion of a nuclear weapon in outer space in the Indian Ocean area would result in a total blackout for 14 hours of use of all radio and radio communications in the Moscow, St. Petersburg and Leningrad areas.

Release of a nuclear weapon in the South Atlantic in strategic locations also would result in a total radio and radio communications blackout, Johnson said.

Johnson said that the U.S. has not yet conducted all of the information gained from the Argus tests and that some of the initial conclusions may have to be altered. He also told the congressional that

■ **Studies are under way** on a project to place a 1,000-ton nuclear platform into space using the detonation of solid rocket boosters for lift. Studies will cost about \$1 million.

■ It would be possible to construct satellites and engines for do-it-on-your-own quick projects much in the same manner as professional men are now drafting for cars in the amateur hobby field who would be opposed to use such devices.

■ It does not feel that the military-satellite liaison committee as provided in the National Space Act of 1958 is necessary because present congressional and executive branches of the government have separate and independent programs. Also, radio command guidance systems, being developed for Titan, Ball Telephone Laboratories and Hughes based on a technology in America's current space program was assigned to Titan. New Air Force plans to go forward in all its ICBMs, but is sufficient to get off of the ground, involving the type of hardware and hardware needed for recycling mission.

■ **Improvements** in the satellite deter-

tance force now under construction in the southern U.S. will make it impenetrable for any country, in order a satellite at least 200 miles up in orbit at altitudes of up to 1,000 m without the U.S. knowing it. Other improvements within a 100 m will disrupt the missile defense system.

■ **Current half** of ARPA's total procurement strength of \$8.5 billion is engaged in research for a defense against electromagnetic pulse missiles, including the death ray concept.

■ **ARPA** also has a contract with Bell Corp. to detail work and less for the U.S. to go into space during the next 20 years.

■ **ARPA** has saved the nation "billions of dollars" of dollars by preventing duplication of space projects but that it must remain a coordinating agency and not become a fourth operating agency.

■ **In the event** of a total Strategic Air Command alert, there must present and valid communications to alert the command to start air strike operations.

Johnson's report on the steps on the development and test of the radio communications network.

Johnson continued to recommend that the Army Ballistic Missile Agency review within the Defense Department rather than be transferred to the Na-

Titan Guidance Switch

Washington—A Titan will switch from its normal guidance for its March 1995 antisatellite, ballistic missile and experts to some alternate if one fails within two weeks. Four computers are in the lead management AD Space, Inc., Kirtland, New Mexico, and Northrop's Northrop Division.

American Space Arms' missile option, originally developed for the Titan, was redesigned to the Convair Atlas instead because when USAF decided that was also available and joining another missile in the space warfare portfolio of the service became a priority.

■ **Guided Electronic Ballistic**—The radio command guidance system. At the same time, radio command guidance system, being developed for Titan, Ball Telephone Laboratories and Hughes based on a technology in America's current space program was assigned to Titan. New Air Force plans to go forward in all its ICBMs, but is sufficient to get off of the ground, involving the type of hardware and hardware needed for recycling mission.

■ **Improvements** in the satellite deter-

rence Armstrong and Space Administration as proposed by NASA.

T. Keith Glavin, NASA administrator, told the subcommittee that:

- **Top-level Space Council**, established by the president's top policy group on space matters, holds regular meetings. Four meetings of about 100 people from each field held the past five months—Sept. 24 Oct. 9, Dec. 3, and Mar. 2. All of the meetings were provided cost to the President.

■ **Executive secretary** to manage the functions of the Council had not yet been appointed. The Space Act authorized a secretary, to be appointed by the President and confirmed by the Senate, at a salary of \$100,000 a year. An "acting executive," Franklin Phillips, is now with NASA at \$16,000 a year.

Glavin reported declined to give the subcommittee details of the \$600 Smart Strength (D-3 M-1) an solar array as the deliberations of the Council on the grounds that it is a confidential service to the President.

Glavin's report on the steps on the development and test of the radio communications network.

Johnson's report on the development and test of the radio communications network showed that the Council did not have permanent.

There were many meeting between representatives of NASA and the Department of Defense as the source of effort. Two meetings were held, both presided over by Dr. James T. Rohan, the President's scientific advisor. The experts were Deputy Secretary of Defense Donald Quisenberry, Dr. Michael York, Defense Department director of research and engineering, Lawrence Goss and David Young of the Advanced Research Projects Agency, Glavin, Dr. Hugh Dryden, NASA deputy administrator, and Dr. Robert Schenck, NASA director of space and development. The meetings were also presided over by Dr. George and Dr. Robert Glavin and presented to the Budget Bureau, which chairman the space air construction facilities.

The enhanced space program studies the President via the Budget Bureau, Glavin said, and the President can then seek advice of National Aerospace and Space Council if he wants.

Glavin said that Dr. Kilian also serves as chairman of the working level military-space committee to reduce duplication between ARPA and NASA.

Tom Spangler pointed that there is no overall national space program nor even plans to develop one. Glavin replied, however, that although there is "one half of one" all the individual projects "will together form a national program."

Detailed Sun Pictures Recorded By ONR Aerobee-Hi Rocket

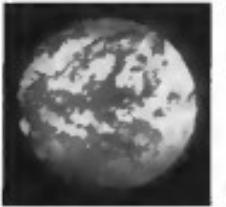
Washington—First highly detailed photographs of the solar sun using ultraviolet radiation originating in the outer portion of the solar atmosphere was obtained on March 13 from an Aerobee Hi rocket at 123 mi altitude.

Specialized cameras and filters which were sensitive only to light of the Lyman-alpha line of hydrogen in the ultraviolet region of the continuous solar spectrum produced photographs which indicate that such radiation is emitted from spots and patches over the solar surface.

Transmissions conducted by Office of Naval Research scientists as part of the U.S. participation in the International Geophysical Year program, radio sponsorship of National Academy of Sciences, Rocket carrying the special photo equipment was launched from White Sands Missile Range.

Ultraviolet and X-ray radiation from the sun, impinging upon the earth's atmosphere, produces the ionospheric layers in the upper atmosphere which reflect radio waves in the high frequency (HF) band and at lower frequencies used for long-distance communications. Special instruments can estimate solar disturbances or known to produce disruptions in long-range radio communications and changes in propagation. Scientists also suspect that such solar radiation may play an important role in determining seasonal weather conditions.

Because the reflection is attenuated by the earth's atmosphere, it has been



FIRST ultraviolet photograph of the sun's atmosphere was taken from an Aerobee-Hi research rocket fired by Naval Research Laboratory scientists to an altitude of 123 mi from White Sands, N. M., on March 13.that shows the hydrogen Lyman-alpha radiation.

impossible previously to make an ultraviolet photograph of the sun from the earth. This had made it impossible to correlate the intensity and location of such solar radiation with the same phenomena as viewed in the visible light spectrum through telescopes.

During the recent experiment, several ionospheric photographs of the sun were made on the earth using solar radiation emitted by two solar wavelengths, the red free of the spectrum and the violet, blue of the same color.

Photographs were made at the Mount Wilson Observatory in California, the McDonald-Hefner Observatory in Michigan, the Air Force Observatory at Sacramento Peak in New Mexico and at Naval Research Laboratory in Washington.

The ultraviolet-Lyman-alpha photographs show the solar weather picture at the highest level in the solar atmosphere yet studied over the entire solar surface, with the calcium K-line skipping the atmosphere farther down into the interior and the red line of hydrogen photons showing the pattern still lower in the solar atmosphere.

To summarize, the three will give a three-dimensional picture of the atmosphere, NRL indicated. When viewed by the extreme ultraviolet light of hydrogen, the sun appears extremely distorted. The same bright, distorted sun also can be seen in the photographs made by ground observatories, but are smaller and less complete.

Through the use of rocket interests, NRL scientists hope to be able to obtain daily solar weather reports and use them to predict their reactions to the earth's weather and radio communications.

The system used to make the ultraviolet solar photographs was developed by NRL over the last four years. Because ultraviolet radiation is absorbed by air material, a conventional lens could not be used. The camera had to be constructed using diffusion gratings, which function as optical mirrors and filter to pass only ultraviolet Lyman-alpha radiation.

Special film also had to be developed because the positive border itself in ordinary emulsion would absorb ultraviolet radiation before it reaches the sensitive silver halide grains. Special film used contained almost no gelatin, but this required extreme care in handling to preserve the image.

The camera was aimed at the sun and stabilized against rocket rolling, pitching and yawing motions by means of a photocell-driven stabilization system which was built at the University of Colorado.

Demand Is Increasing For Avionic Engineers

New York—Demand for electronic engineers may be headed for new peaks, an American Week spot check of the recent national convention of the Institute of Radio Engineers has revealed.

Recruiters for nine companies representing perhaps 20% of those actively recruiting here told American Week that they will have a total of nearly 6,000 engineers during the remainder of this year.

Although most recruiters reported fewer job applicants than at last year's IRE convention, nearly all said that the quality and experience level has risen considerably higher. Possible explanation is that among last year's applicants were many left by industry leaders and friends, with the latter now having tight as the date of expiration.

Salary levels are up slightly, ranging from 5 to 10% over last year, most recruiters agree, except for such sought specialists and experienced men. Engineers with routine engineering, digital computer and telecommunication are much in demand, but companies generally are seeking talent throughout the electronics field. Junior engineers with five years or less experience are being sought by companies such as Armstrong Systems, Lockheed and Sperry-Teknion. Laboratories continue to recruit not only present employees but PIs.

In addition to advertising by individual companies, several employment agencies were active at the IRE convention. One placed many jobs in all categories local, please look for continuing applications to fill job opportunities.

Results at the fall class of recruiting won't be known for several weeks.

Recruiters are mixed in their opinions as whether the situation will get worse first in the coming months. Those who expect demand for engineers to grow point to the increased percentage of research and development required for space technology and the growing numbers of companies seeking to get into that field.



U.S. Army's 5th Artillery Group test cast equipped with Redstone intermediate range ballistic missile in series shown, studies the IREEM for placement at Fulda, Germany.



First Overseas Redstone Unit Trains in Germany



Redstone here in a closed field in its transport position. At right: Missiles stacked liquid oxygen fuel are stacked. The Redstone unit based at Cape Canaveral, Fla. (AW June 2, p. 49) in a year before its transfer to Germany.





FLOATING while in a weightless condition are Maj. Edward L. Brown, left, and Lt. Marvin Gresham. Lt. Gresham projects himself about the other using a compressed air weapon gun.



COMPRESSED air reaction system (left) consists of six balloon bottles strapped to subject's back. At right, test subject walks upside down, on C-118B ceiling, using reaction device.



Weightless Experiments Detailed

Walking—Men can become inverted and fall right side up while standing on the floor when they are weightless according to initial findings of Air Force scientists at Wright Air Development Center. It may be important, however, for men to use a reaction unit or flying belt type of device for individual control when they are weightless.

Tests have shown that when weightless conditions are created by the taking of a test aircraft using ballistic seats, someone feels that everyone else in the aircraft is upside down. This phenomenon has been verified with several different persons during flights in a modified Convair C-118B. Tests were conducted by the Crew Survival Research Section at Wright's Aero Medical Laboratory's Engineering Psychology Branch (AW Doc. 73, p. 35).

These flights using a Keplerian陀螺仪 (gyro) to sense the aircraft and those in it in a weightless condition for 12 to 15 sec. under normal conditions. Tests that have shown that people who do not pass over the movements of liquids in space have shown that liquids tend to move in great globules during zero gravity and bubbles move randomly.

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NATO Hawk Delivery May Begin in 1961

Paris-based production program for the building of the U.S.-designed air defense missile, the Army-Bell-Hawk, by the NATO nations of west Europe reportedly will resolve 22 battalions with initial deliveries slated to begin in June 1961.

Final approval of the program by NATO council is expected sometime in April. This will mark the first success of U.S. policy since the 1957 NATO summit conference. At that summit, President Eisenhower promised NATO nations the U.S. would help establish in Europe large-scale joint forces of national type groups.

In addition to the Hawk program, arrangements for European construction of the Sidewinder missile are also nearing completion.

Initially, the Hawk program was aimed at 18 battalions, but France, because of budgetary considerations, has now reduced its participation by two-thirds. While final details still remain to be worked out, the program currently is divided as follows:

West Germany, nine battalions; Italy, five battalions; France, three battalions; Belgium, three battalions; and Holland, three battalions.

Cost of the program for the five nations involved is estimated at \$440 million. U.S. financial assistance, which totals \$100 million for the year, will be taken progressively so that it is expected to run until 1964 and will be about \$40 million after that period.

While the initial Hawk program has been fixed at 22 battalions, this figure can be increased by six or eight battalions if the U.S. later decides to place all these orders for the Hawk in west Europe. The possibility also exists that European nations involved in the program can, in the future consider their participation. Some observers expect that as many as 10 Hawk battalions can be applied to the European theater.

Foreign companies involved in the Hawk program are Avionics de Construction Electrique de Charleroi, Belgium; Telefunken, Germany; Pavesi, Italy; Philips, Holland, and Thomson-Houston, France. Despite delayed French participation, Thomson-Houston will assist in technical assistance of the group.

Additional European companies will come into the program at intermediate time. It is expected France and Germany will join their efforts, as will Belgium and Holland.

Overall management company for the group, named Societe Europeenne de Technologies, has set up an international committee under French pres-

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Pluto Design Proposals Evaluated by ARDC

Washington—Evaluation of three major studies outlining possible future uses of nuclear-powered aircraft has begun at a new center created by ARDC.

Studies were performed during the last three years by Chase-Vought, San Diego Division of Convair, and North American Aviation's Missile Division. Completion date for the studies was July 22.

Such a vehicle, in its simplest form, would be little more than a flying magnet with the nuclear reactor implying the conventional combustion chamber (AW Mar. 2, p. 38). The payload would be carried in the cylindrical canister of the diffuser section of the magnet. Present aerodynamic information indicates that such a cylindrical vehicle would not need wings to enter at the upper speeds.

Edward M. Meek, technical director of the Atomic Energy Commission's Project Pluto which has been performing research on nuclear reactors, has testified that their powerplant is feasible with present knowledge and that they may be constructed with currently used materials. Merlin says, "It is just a matter of do you want it or not."

Pearson plans to call for ARDC to give the Air Staff an early briefing on the possibilities of nuclear aircraft studies as outlined by the companies which have submitted the design proposals. Air Force Weapons Board emerged of general offices and headed by Maj. Gen. James Fergason, USAF director of requirements, also will review the proposals and ARDC's presentation.

Controllable Stage Employed in Mecha

Moscow—Use of a controllable fuel stage for the recent Soviet Mecha solo satellite (AW Jan. 12, p. 36) and the ability to make minor impact changes of the payload after separation from the final stage appear to confirm the apparent precision of the probe.

A recent article in *Pravda* reports that "control of orbit of space probes" out to distances of 100,000 km was successfully piloted by a "special device" developed for operation at 15.5 sec. Separate instruments operating at approximately 20 sec were used to determine both scientific data. Article does not indicate how trajectory corrections were produced in probe.

"Automatic radio stations were used to track Mecha during the early portion of its flight, but subsequent impact determinations were made by an interconnected network of radio electronic stations throughout the USSR."

This suggests that the Russians are using a radio-linked guidance system similar to one developed in the U.S. by General Electric/Burroughs employing Doppler techniques for guidance of the Atlas intercontinental ballistic missile.

More information at handout was accidentally destroyed. Pearson says, "In order to achieve a velocity which would bring the probe into the vicinity of the moon at a time when it could be viewed by [radio stations located in the territories of the Soviet Union, as well as in Africa and in the large part of Asia."

Servo Corp. Designs New Omnidrome Unit

New York—New type of maneuver designated Doppler VOR, which provides continuous Doppler navigation over long distances, is being refined by the National Bureau of Standards. The technique, which may be named "Doppler Omnidrome," will be marketed by Servo Corp. of America.

New Doppler VOR is fully compatible with existing airborne receivers with our modifications and special procedures (AW Oct. 11, p. #1). Evaluation tests conducted by Federal Aviation Agency at an extremely unfavorable elevation, 10,000 ft, in Chadron, Neb., showed over 90 stations over an 80 deg. compassable in short distance from conventional VOR at a good resolution. New type VOR makes it possible to switch the station at an optimum location for the en route receiver without costly clearing operations.

Lockheed Acquires Seattle Shipyard

Los Angeles—Lockheed Aircraft Corp. has purchased controlling interest in Puget Sound Bridge and Dredging Co., Seattle. Acquisition will focus originally on needed port facilities and ground support facilities for missiles and space vehicles. Robert E. Goss, Lockheed board chairman and the single largest stockholder in Seattle's harbor will give Lockheed a participation in the promising potential of ship construction, maintenance, repair and repair for the naval fleet, U. S. Merchant Marine and other shipping.

"With our planned investment in new additional facilities, we believe we may become eligible for a part in building space shuttles, which apparently are destined to become the capital ships of the future," Goss said. Details of the transaction were not disclosed. Except for the planned expansion, no change is contemplated for Puget Sound's management personnel or policies.

News Digest

Cessna Aircraft Engineering Corp. has received a \$100.7 million contract for development and production of the Navy AF-1 fighter attack aircraft. Contract is the first to be let by NASA as a cost-plus-incentive fee system which corresponds to profit on a basis of the AF-1's actual over-all performance, as well as on Cessna's control of costs.

North American X-15 high-altitude research aircraft made record captive flight last week beneath the wing of an B-52 mother ship flight, lasting 1 hr. 45 min. was made from Edwards AFB, Calif. Indications were that the flight was routine, with no complications noted.

West German government's order for 130 *Stal Alouette* helicopter-powereed helicopters brings the company's Alouette order backlog to 400.

Seaboard and Western Airlines agreed to acquire a quarter share in Aerobatic, the transatlantic jetliners subside, as of December 1, 1965. A government announcement gave no reason for the decision.

Russian Alexander Neustroyev told the USSR Academy of Sciences there is no doubt Soviet exploration of the moon and manned flights will be achieved by 1965.

Italy and the U.S. have completed formal agreements for the storing of Jupiter intermediate range ballistic missiles on northern Italy. Missiles will be stored in Italy with the nuclear warheads in the custody of U.S. personnel. Under the agreement, it will remain as under arms from both governments, unless the warheads can be used. Training of the operational troops in Italy will be conducted by Strategic Air Command's 34th Strategic Missile Squadron.

Domino as a contractor for operating and maintaining the Pacific Missile Range is scheduled to be made by Navy by the middle of this month. Purchase of the contract will be similar to that of Pan American World Airways at the Air Force Manned Test Center, Cape Canaveral, Fla. Domino includes Convair, Pan American, Pacific International Telephone and Telegraph, Lockheed Aircraft Service, Aeronutronics General and Italian and Naval, a West Coast engineering firm.



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then bushell fell heading commences burn and flight planning even when the autopilot is off. The third pilot is an armed officer, now performing traffic watch through the windows while the other pilots are free, and he takes a pilot's seat when the captain or co-pilot leaves it temporarily. The third pilot also will act as backup for the flight engineer when that crewman leaves his station, Bond said.

Among the other reports to SAE's annualized meeting was a paper on Eastern Air Lines Lockheed Hercules turboprop, she scheduled for delivery next Friday.

Charles French, vice president-engineering, said introduction of the Hercules' Eastern version involved considerable concentration of resources at both operations and manufacturer.

Problems in the Hercules are to be anticipated with the type of aircraft, French said, although many of them could be eliminated by better attention to detail design and "the application of sound logic" during the design, development and testing stages.

Many difficulties experienced with the Electra's electrical systems have resulted, according to French, from "firm" terminals and components such as switches, relays, rheostats and inadequate insulation and connections where the addition of 7% fuel causes heat and there would have presented many problems. In some cases, the Eastern official said, this has been a source of a "pennywise and pound-foolish" policy which he approves when he sees it at this point.

Fairchild had to reverse an engine within a few hours of the delivery of its first Electra because of engine damage, French said, and Fairchild had worked out over \$18,000. The cause

apparently was a metallic object dropped into the engine outlet scoop. The grounding lead of 110 hr of daily operation, French said, would bring through the windscreen a range of inspection, maintenance and terminating location. The Allison 501-D63, installed more than 190,000 hr of after-turbine, ordinary operation, was said during final development compressor problems trouble had caused intense difficulties and excessive friction, French said.

Bugs in various Electra variants have been encountered. French indicated more or less at the usual pattern of new aircraft operation. Some of the problems have been minor as others and made repeatable while others require a strict program to determine the causes.

French said the smoothness and low noise level vibration of various aircraft has remained excellent, except for the unanticipated and unexplained Centauri effect. This is a particular line of the Electra with a comparatively low power loading and high propeller disk loading, up to 40% in clearance between blade tip and fuselage, he said.

Electra airports were limited recently pushing investigation of some vibration problems (AW Feb 25, p. 37).

French said the highest fuel to distance ratio of Eastern's Electra is about 700 hr, hardly enough to induce the engineer with each component. Several times, however, more room for fuel storage, he said. Agreeing that the engine starting system which requires a ground power unit costing between \$15,000 to \$25,000 per unit. This he called "an unnecessary waste."

An auxiliary pump can extend the aircraft to provide both engine start and deicing requirements, though he is dubious of the practice, French suggested.

French said a unit would add to ground time to loading and during which work gear was retracted.

Other problems awaiting solutions, he said, are prevention of noise, torque converter and turbine blades and other engine parts, simplification of the electrical system and protection against damage, including propeller problems against deflected birds.

Eastern has gone through its transition period to various aircraft without serious incident, French said, "except for departure delays which we avoid the customers."

American Selling 45 DC-6s to F. B. Ayer

New York-American Airlines has contracted to sell 45 of its 50 Douglas C-6 series planes to F. B. Ayer and Associates, aircraft dealer which already owns 30 of American's Convair 240s. The latest agreement also gives Ayer first right of acquisition for the remaining DC-6s.

Overall value of the fleet DC-6s is \$30 million, exceeding 14 American.

The airline thus has arranged in those last 10 months to take half its fleet in 15 months' time. Delivery of the DC-6 to Ayer will be made as the planes are phased out of American's operation, with final delivery scheduled for January 1961.

Included in the DC-6 sale are 80 par voix, 44 passenger and 16-passenger DC-6s, 62 passenger DC-6Bs and five DC-6 cargo airplanes. All the planes will be from two to eight years old. Engaged, positive and airborne time will be less than 500 hr.

An average load of 80 tons each time but September and Oct. that purchase value at \$45.5 million.



AW 650 Simultaneously Loaded Fore and Aft

Twelve tons of freight are simultaneously loaded through fore and aft cargo doors of the tail-dragger Armstrong Whitworth AW 650 Auger 600. Six tons of freight are being loaded into the forward door while another ton has been loaded in the aft door. Controls and instrumentation layout of the AW 650 are at right. British Airlines has signed a procurement order for four AW 650s.



Takeoff Power Responsibility Given to Engineers by Eastern

Washington-Eastern Air Lines' flight engineers have been given full responsibility for taking and check-powering aircraft, the Lockheed Electra in the latest bid by the airline to reduce its growing problem of jet engine failures (AWW Mar. 23, p. 31).

Eastern has been experiencing an interaction dispute between some of its pilots and engineers, in which engineers claim pilots are endangering flight operations and creating maintenance problems by abusing rotary engine controls.

Eastern's premium engine research for both piston engine and turboprop equipment in January were high on the number needed for the next month last year. Despite repeated efforts to flight test the engines, the company's maintenance department, pursuant to results for February exceeded those of January, which were characterized by Eastern as "an operational problem of the first magnitude."

Citing a compilation of some than 200 complaints filed by the Flight Engineers International Association with the Federal Aviation Agency, the engineers claim pilot enthusiasm with correct flight engineering procedures at the key to much of the current maintenance problem. The problem has been made apparent as a result of continual use of engine power and load of stability of flights, with resultant extreme cylinder head temperatures, they say.

Eastern spokesman advise the maintenance problem cont. and assure that the figures "would suggest abuse" of engine operating procedures, but they deny there are any erroneous conclusions between the role in preventive engine research and mutual agreement between pilots and engineers. Primary



Comet 4 Claims Intercontinental Flight Record

Recent flight from England to South America was claimed by an Aeroflot Aeroflot de Madrid Comet 4 on a defense flight in March. Elapsed time from takeoff at Madrid, England, to arrival Buenos Aires was 19 hr 21 min. Total distance covered 7,051 mi; average speed was 343 mph.

46

trouble and the trend is toward further deterioration," the response will at flight personnel.

In a seven page report to all captains, pilots and flight engineers, Eastern spelled out many of its maintenance problems, advised captain operating procedures to avoid further trouble and observed that "it is a matter of record that non-standard and widely varied procedures can bring a major crisis in the wake of breakdowns."

BEA, Aeroflot Sign London-Moscow Pact

London-British European Airways and Aeroflot will begin the first direct scheduled service between London and Moscow this summer.

The Anglo-Soviet air services agreement comes up in February was signed last week in Moscow.

BEA says it hopes to begin service with the Russian airline in June, but the two airlines will also commence cooperation and interchanges on the Allianz 904D-12 regional planes and points out that the Russian carrier's familiarity on the passenger services they will not be operated in excess of 97°C for turbine inlet temperatures as follows: 600 kg. Eastern reported 19 hr flight hearings of British airways that the Fabrasy at equipped with only 81 for the previous month of the year.

Passenger services for piston engines started 85 in February, as compared with 45 in January. In flight hearings dropped from 37 in January to 50 in February. Elsewhere in the airline and the two countries, bookings are due presently to augmented long-haul maintenance, designed to spot faults as early as possible, and to minimize damage to aircraft.

Other western airlines now serving Moscow include KLM, SAS, Swiss, Air France and from the east, Aeroflot.

Westland Opening London Heliport

London—London's first heliport, being built by Westland Aircraft Ltd., on the River Thames at Battersea, will open April 22.

The new landing facilities will start operating the following day, but until the heliport is fully being operated under present license, operators must give full prior notice of intend to use the complex area.

Services will include radio communication and navigation aids, refueling and testing and parking for up to six medium-sized helicopters. A central administration building will provide garage facilities. Contract and management close care for passengers and freight can be arranged if prior notice is given.

The company is planning installation of lighting sufficient for landing and takeoffs at night, but the heliport will initially operate during the day.



Western's First Lockheed Electro Nears Roll-Out

First of nine Lockheed Electra transports being built for Western Air Lines were completed at Lockheed Aircraft's Burbank, Calif., plant. Aircraft will be delivered sheet June 6, initial service is scheduled for August after delivery of third Electra.

CAB Requests New Legislation To Establish Inspection Rights

Washington—Civil Aeronautics Board has asked Congress for legislation giving the Board authority to inspect the records and instruments of airline trade associations.

In a petition to Sen. Warren Magnuson (D-Wash.), chairman of the Senate Committee on Commerce, CAB Chairman James R. Dorsey said that although the Federal Aviation Act gives the Board authority to inspect airline records, "there is doubt in it in the administration of the Board to measure the books and records of various companies to be as accurate as possible, so the decision was made on an erratic or at sometime of the inspecting public, unless effective supervision is exercised by groups of six carriers."

CAB recently launched a full-scale inspection and review of Air Transport Asia (AWW Mar. 30, p. 47). ATA has not challenged the Board's legal authority to subject its records.

Other legislation requested by CAB for the first time this past, and again denied by Sen. Magnuson, proposes

* Powers for "helping an airline institution." The Board said that the practice "has grown to such an extent as to constitute a substantial burden on the orderly development of insurance and transportation."

"The adverse effects of the practice are particularly evident on the most heavily traveled routes, such as that between New York and Miami," the Board said. However, with the increasing demand for air transportation throughout the country, it may be expected that these practices will be continued, but these practices will be limited with an intent to it of service corporations controlled by groups of six carriers."

The consumer petition disclosed by Board inspectors is for an individual to make reservations in anticipation of a heavy travel demand and thus the tickets, plus a premium on the fare, generally ranging from 5% to 10%.

* Decline a congressional policy that

the Department of Defense should enter into competition with commercial airlines. Airlines representatives argue that a policy declaration will be effective in shifting military business from Military Air Transport Service to commercial carriers.

* Authorize CAB to regulate the air transportation accounting of air carriers. U.S. citizens could do a better job. Also, Airline Safety Act. CAB would shield the Board's authority to do this, but the decision was reversed by the U.S. Court of Appeals, and the Supreme Court declined to hear the case.

Noting that depreciation is becoming an increasingly important operating expense for an airline with the addition of new and more expensive aircraft equipment, CAB said that "depreciation charges for depreciation would undermine the strength of the financial statements to justify the same manner as insurance charges for solar ice, typhoons, and other operating expenses."

* Permit the Board to make independent representations to court-judged cases. CAB was most work through the Attorney General.

* Direct the Board to dispense with hearings in cases where they are not



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The less payload means that changes the transport equation. This is true particularly of air freight where quick turnaround is essential if costs are to be kept to a minimum. With the Argosy, a quick-loading system is being developed that will enable the four freight bays to be cleared and filled again in a few minutes. With roll-back doors at either end of the fuselage, the load can be discharged at one end while the new cargo is being loaded at the other.

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straight by anyone with a substantial interest. In many simple communities, such as the last of a limited number of service, CAB and the hearing serve no useful purpose.

*Except Board Personnel from tenth-grade education or from having been serving members the Board has no expertise. Further information developed by the Board would be made available to migrants to the extent it is not reasonably available elsewhere.

Other measures proposed by CAB have been sought for several years by the Board, but never enacted by Congress. They include:

- Increases in penalties for violations of CAB commerce regulations. Current penalties would be raised from \$500 minimum for a first offense and \$2,000 for a repeated offense, to \$5,000 minimum for a first offense with each subsequent day of violation being counted with a separate offense. Civil penalties up to \$1,000 would be introduced for minor violations. ATA has opposed certain provisions on the grounds that they could "make life hell" for the airlines to death."
- Authorize CAB to provide certificates for licensed types of aircraft.
- Separate by law other powers for carrying mail from subsidy provisions.
- Permit airlines to offer free or reduced transportation to retired personnel and their families.
- Authorize the Board to regulate the rates of U.S. carriers in international aviation. It already has the authority to do domestic rates.

**Jet Control Procedures
Outlined by FAA Unit**

Washington—Final air traffic control procedures can be applied to helicopter transports without impairing efficiency or safety of flight operations according to a preliminary report on non-aircraft control issued by the Technical Operations Center.

The report potentially achieves efficiencies that jet aircraft will support highly mobile holding patterns in high demand terminal operations—a procedure also considered essential at a holding distance. If the proposed test concepts in the field of aerial scheduling result that can be applied in the development of equipment design and operational philosophies in future air traffic control systems.

The report is based on findings resulting in air traffic control results not conducted by the Technical Development Center of the Civil Aviation Administration prior to its integration into the Federal Aviation Agency. Highlights of the report are:

- Low-altitude holding patterns permit higher utilization of approach routes.

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Qantas Nears Start of Boeing 707 Intercontinental Service

Qantas Empire Airways, the Australian airline, will start Boeing 707-400 jet aircraft service from New York to London July 25 and to Australia July 31. A Qantas 707-400 also will serve as New York July 29 from Sydney, en route to London.

Thus high altitude holding patterns, fuel economy reduction in delivery will more than compensate for the increased fuel flow rates of jet aircraft flying at low altitudes at high density terminal areas.

* **Turbots** should be used instead of turbines in cases where jet transports cannot be cleared for unassisted climb.

* **Development of advanced approach systems using paragliders.** Tracking reservations will reduce amount of long-haul holding without reducing accuracy rate of the approach system.

* **Fuel management** was found to be the most important method of adjusting operating intervals.

* **Emphasis** was placed on the need for a thorough understanding by operations personnel of civil jet aircraft operating characteristics and limitations to ensure efficient integration of jet into the present air traffic control system.

The report noted that simulation tests indicated high speeds of jet aircraft will present a problem to controllers who are not experienced in handling

jet aircraft at higher rates of descent with other aircraft and the low landing rates required for passenger comfort. It added that one of the most important jobs the controller will have will be to become accustomed to "staying ahead of the aircraft" and to the increased operating range of jet flights.

The report pointed out that the high rate of fuel consumption will make it desirable for pilots to complete pre-takeoff engine checks prior to starting engines. It also said that it can be easier to control descent if jet pilots become aware that ITC descent limits below 10,000 ft.

In this connection, since no engine warning is provided for turbines, the report recommended a bypass to move the pitot probe to prevent unanticipated rise in descent position. The report said a four-second bypass, starting at 10,000 ft, will limit 180 ft of fuel per minute.

As a means of adjusting arrival times of each aircraft to its needs, especially in the stream of moving traffic, the report recommended velocity control and precision flight descent rates to better techniques to be added to the holding and descending systems now in general use.

The report was prepared by Paul T. Appleby and Tracy K. Vining of the Federal Aviation Agency.

Airport Incident

Proposed by ATA

New York-East of New York Airports, Inc., and the 21-year-old airport and its lessees who are to be allowed to see the rights and broad therewith exclusively needed by Public Health Officials. The vendor left the observatory deck of the International Airport Building by an emergency exit, wound up struggling with a stream of arriving continental passengers. Since they had been exposed to possible fomite infection, Public Health insisted on getting them home. Their objection to the application is passed at \$6,000 each.

Washington-Legislation advanced by the Air Transport Association to facilitate the financing of jet flights appears to be non-controversial in Congress. The two provisions of the measure would enable airlines to issue a valid termi-

nally interest in specifically identified jet planes notified in writing. This may be done at parson's option to engines.

* **Except** holders of security interests in engines and propellers from holders. Holders of security interests in complete aircraft or already except from liability arising from accidents or other causes in the operation of the aircraft.

At hearings held with before the Senate Committee Subcommittee headed by Sen. Mike Mansfield (D-Calif.), J. D. O'Connor, assistant general counsel of ATA, said several options should be left open to Congress. One proposal he suggested has portions of fuel savings propellers for jet technology that will reduce by \$1.5 million in fuel and the capital costs and is an absolute necessity if the function of jet engines is to be maintained," he said.

Manufacturers are unwilling to loan

propellers. Present cost makes their interest interest in duly and specifically partitioned.

Financing agencies are also unwilling to research finance cognos or paperless unless they are exempted from liability arising from the operation of the aircraft, O'Connor pointed out.

The measure also was endorsed by the United Airlines, American, Pan Am, Trans World Airlines and the General Aircraft and Leasing Co. Bradley Shaws, representing the lessors firm, proposed an additional provision that security holders be freed from liabilities resulting from accidents occurring in the air as well as on the ground. The present exception, applying only to ground crashes or other severe incidents, should, after the security holder as pro tanto from liabilities arising from individual collisions.

SHORTLINES

* **Aeroflot Airlines** received its Boeing 707-120 transcontinental monitor New York-Los Angeles flights from two to three daily April 1. The new flight leaves New York's International Airport at 11:45 a.m. and arrives Los Angeles at 2:15 p.m. Return flight leaves Los Angeles at 3:45 p.m. and arrives New York at 10:30 p.m. All these are local. Americans will begin Lockheed Electra routes to Chicago from Washington April 12, with two round trip flights daily, and intends to increase frequency of flights as new Electras are delivered.

* **Northwest Airlines** carried 133,770 domestic passengers during February, a 22.8% increase over the same period last year. Total revenue passenger miles flown for February were 108,713,000, up 45.9%. Revenue ton-miles increased and domestic passenger ton-miles up 28.40%, 24.7%, and 61.391,000, up 45.4% respectively. During February Northwest showed a net loss after taxes of \$49,127.

* **Pan American World Airways** has carried 50,000 passengers between the U.S. and Europe on its Boeing 707-120 aircraft. Only three of Pan American's six jets were needed on the route.

* **Seaboard & Western Airlines** has opened new sales offices in San Francisco and Honolulu. The carrier now offers air travel to Europe from the U.S., but has applied for permission to extend its routes to San Francisco/Oakland to the Far East and southeast Pacific. Airlines has recently been involved in the Pacific Airline hereinafter San Francisco and Tokyo. It carried some 30 million lbs of cargo, and had passengers on 3,500 flights since the Pacific.

* **Twa World Airlines** flew 265-413,116 revenue passenger miles on its domestic and international flights for a 195% increase over the same period last year. TWA attributes much of the increase to the newly opened St. Louis-Memphis routes and northeast service on East to West Coast carriers. During the first week in March, 1,580 persons booked reservations on TWA's flights to Europe for the period prior to June 1-37% higher than the previous week.

* **United Air Lines** flew 344,245,000 revenue passenger miles during February, up 40% compared to the same period last year. Mid-month total revenue rose 11% to 2,653,000, flight ton-miles up 27% to 5,351,000 and revenue ton-miles up 83,000, revenue, up 21%.

AIRLINE OBSERVER

* **Federal Aviation Agency Administrator Elwood Quisenberry has instructed regional administrators, attorneys, bureau of flight standards chiefs and supervising inspectors to tighten up enforcement activities. In an impromptu meeting in Oklahoma City, FAA personnel were warned against any softening of enforcement of civil air regulations and were given what Quisenberry calls the "Fare P" formula as a guide to conducting enforcement proceedings. First it's the fact, then red form.**

* **Western, Eastern and Panair Isle Air Defense Identification Zones (ADIZ)** existing virtually across the U.S. were eliminated last week and flight controllers writing the terminating zones were advised. Elimination of the three ADIZs became possible with the cancellation of the U.S.-U.S.S.R. agreement to establish an offield ADIZ from the Gulf of Mexico to the Pacific. Requirements calling upon the established Adriatic, Gulf of Nicoya, Puerto and Caribbean borders. Pilots now flying in any of the remaining ADIZs will no longer be required to file defense coast flight plans when operating at a maximum speed of 150 or 3,000 ft altitude or less. Formerly, pilots were not required to file a DVFR flight plan when operating at 100 ft, below 1,500 ft.

* **Civil Aeronautics Board** has agreed to hold its hearings directed to the president of the Air Transport Association in accordance with 49 CFR Sec. 30, p. 42. Schipper was issued when ATA gave only "restricted access" to its files in the course CAB review and inspection of the association. The Board said it deemed it appropriate to hold the hearings in accordance because of an "unqualified omission" by ATA that it would cooperate in the defense of the Board in the investigation.

* **Load factor** for seven local service carriers during February reached 42.3%, an insignificant gain over the 41.9% recorded in the same month last year. Available seat sales for the seven carriers rose from 70 million to 76 million while revenue passenger miles climbed from 29 million to 33 million in the same period.

* **Significance** behind the forecast American Airlines' President C. R. Smith made of 1970 revenues lies in its departure from his concern not to isolate specific forecasts in spending. Anyways, like a number of other airlines, has shown interest in broadening its equity base now that airline stock prices have risen above book value. Since the end of 1969, American's stock has risen from \$17 a share to over \$16, the highest price for American's shares since a split in 1964. Stock price index now stands at 5,950, up 10% from 5,350 in 1968. Stock price index would exceed 5,950 dollars, compared with \$116 million in 1968, which should not threaten any market difficulties for American's securities.

* **Twa World Airlines** switchboard operations are merging with something of a grouch "Good morning, TWA" from California. BOMC is to be replaced "Good morning, the people of BOMC." Pan American and American have nothing to say about this but National again goes with "We're National Jetline." United has quickly dropped in the radio line. "All names continue to ring to one traditional spring switch. "Reservations are busy, will you kindly wait?"

* **Some** of Russia's four-thousand An-10s liaison transport rate is equipped with compact folding passenger loading stairs which will be carried in the baggage compartment near the cabin's forward door for use while the planes and of "unoccupied" airports. The An-10's high-wing design and low-slung landing gear make of much smaller loading sites than are required for the Tu-104, Il-18, or even the propeller-driven B-18.

* **Military Air Transport Service** has invited customers to take commercial air services to fly passengers and cargo overseas during April, May and June. Current accounting rates at Flying Tiger, Pan American, Alaska, Transocean Airlines, Shik Airway, Capitol Airlines, United States Overseas Airlines, Overseas National Airways and Seaboard and Western.

Westinghouse electrical systems, using first brushless generator, proved in thousands of flight hours



Navy in Full-Scale Production. The world's first direct brushless generator has a key role in advanced electrical systems provided by Westinghouse for today's military and commercial aircraft. The 40 kw units above are standard in Boeing 707 jetliners. First introduced in 1954 by Westinghouse Aircraft Equipment Dept., Lima, Ohio, these dependable generators have performed thousands of flight hours on the Boeing 707 and the Air Force B-52.



Leader in Aircraft Electrical Systems. Westinghouse has been producing aircraft electrical systems since World War II—has built more aircraft electrical systems for aircraft since World War II than any other company. Shown is the brushless permanent-magnet generator with control apparatus.



Longer Service Life and greater reliability result from the elimination of commutators, carbon brushes and collector rings, shown at right. A single thermal resistor handle, held by girl, replaces them. High-temperature silicon diodes produced by Westinghouse research in solid-state technology, make it possible.



Brushless Versus Brush-Type Generator. Both generators are 45 kw. The brushless generator on the left above uses less space and weighs less. Longer life is assured—two cooled brushless generators are guaranteed for 3,000 flight hours, averaging up to 1,200 hours. Brushed generators with twice greater life are under test at Westinghouse.



On-Go-Oil Generator for Convair B-58 Hustler achieves major life breakthrough in temperature rating in electrical generator design—it operates dry. MA-6-7000 oil, having inlet temperature of 360° F., allows generator breakdowns are eliminated—no brushes, commutators or slip rings are used; results greater economy, less frequent overhauls.



AUTOMATIC FUNCTION SIMULATOR, one of the newer testing techniques used by Westinghouse, assures more reliable products—device for electronic systems. This machine subjects protective circuit panel to as many situations as it will encounter in flight operations.



NAVY—The North American A-3D, employing flight test program to prove the F-104, uses the Westinghouse electrical system, including air-cooled brushless generators.



AIR FORCE—The Convair B-58 Hustler employs the Westinghouse electric power system, including air-cooled 40 kw brushless generators.



Robot Circuit Tester was justified later to check continuity of control equipment with 100% accuracy, 60 times faster than present techniques. Westinghouse automatic circuit testing reduces speed production, eliminates chance of human error, improves product reliability.

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INERTIAL GUIDANCE option for Atlas intercontinental ballistic missile, developed by Aerospace Corp., is shown under study last summer by two test flights on Boeing aircraft. Spheres at right contain the four stabilized platforms, heart of the system.

Inertial Guidance Sales Show Fast Climb

By Fletcher J. Shinn

Washington—Nearly a quarter of a billion dollars worth of medical guidance systems were produced last year in U.S. manufacturers and the figure is expected to be 15% higher in 1979, an Attorney General's survey has disclosed. In 1965, manufacturers expect to be producing more than \$600 million in medical guidance systems, the survey indicates.

This represents a considerable growth for a product which didn't exist a decade ago and which had only begun to emerge from the laboratory five years ago. Figures do not include sales of aircraft components, such as gears, or helical platforms used for flight instrumentation, stabilization and fire control.

Increasing solar fluxes reflect the fact that insular surfaces have now become the dominant guiding influence for surface-to-surface and air-to-surface transfers and are causing rate increases for coarse particles of surface-to-air and air-to-air transfers.

Explanation for the increasing popularity of metal guidance over radio guidance is the former's simplicity in substituting to status, positioning and communication. Another reason, in the case of ballistic missiles, is the ability to launch main silicon and the ease of counteracting horizontal forces suffered for external retarding.

Important Significance

Inertial systems also are finding increased use in aircraft for bonding and navigation, not only because of their growing miniaturization but because they, unlike radar, give no tell-tale electromagnetic radiation to warn the use of approaching aircraft. Even interceptors aircraft are being outfitted with inertial navigations to make them more independent of ground-based navigational systems.

At present, fewer than 20 companies dominate the metal matrix field. Only a handful of these hold the bulk of matrix systems production. These include AC Spark Plug Division of

though latex production is now tapering off.

The 11 metal system manufacturers who responded to *AMERICAN Metal's* survey reported a total of \$722 million in sales for 1958 and estimated their 1959 sales at \$824 million.

Credit card estimates of sales for 1963 total \$612 million, about three times the 1958 figure and double the 1962 figure.

Campuses which participated in the survey include AG Spark Plug, Ames Gas Beach Arms, Bell Aircraft, Ford Instrument, International Telephone & Telegraph, Kraske, Litton Industries, Minnesota-Honeywell, North American's Automotive Division, Northeast's Northern Division and Sperry Gyroscope. The survey also disclosed design and technical difficulties.

Potential invited manufacturers were asked to provide the following data on their vehicles:

- Type: point-sensor, stick-sensor or finger sensor
 - Platform design: three-legged, four-legged or no-gimbals
 - Type of gripper: single axis or dual axis, articulated, embossed or other types of grips
 - Type of acceleration: anti-interact, angle-integration or double-integration
 - Type of computer: analog, digital or combination of both
 - System weight
 - System status: in development, pre-production or production
 - Reasons because it is considered classified as a robot:
 -

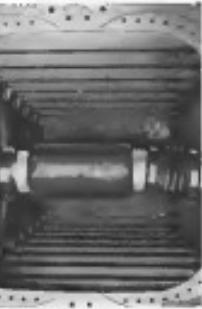
For ballistic missiles and large aircraft which normally are controlled by their managers, a stereotyped platform normally is used, the survey shows. In strategic aircraft, however, six types being developed by Boeing and Lockheed, four guided platforms are used to avoid the problem of guided-lock-on. The aircraft 360 deg pitch or roll maneuver is the exception in the three guided platforms being used in the Kestrel system for the Lockheed F-111 and Convair F-106.

"Stressed-Pause" Structure

Now "staggered" model systems, which do not use standard planar logic-grammar, are being developed by International Telephone & Telegraph (ITT) and by Focal Instruments. This approach eliminates much overhead complexity and weight at the expense of a more sophisticated computer needed to perform the coordinate conversions required for association. Several be-



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RTV compound used for sealing and sealing. RTV (room-temperature vulcanizing) silicone rubber cures without the application of heat; it may take two days up to 8 hours. It won't shrink (no solvents), forms no voids. RTV has excellent load strength—good resistance to high temperatures (about 500°F.), moisture, weathering, ozone, normal acids and solvents. Tough, strong, good electrical properties.

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accelerometers attached to the vehicle. One system of this type being developed by ITT is expected to weigh 75 lb., another is expected to weigh only 45 lb., the company says. Ford Instrument has given no details as to its operation.

In inertial systems computers these appear to be a trend toward digital types, although analog computers predominated in current production. Aviavion Yilanci's survey discusses

A digital computer is mandatory for the strapped-down-type inertial system because of the computational accuracy required.

The single-axis liquid-flashed integrating gyro clearly dominates the inertial rotation field. However, Avco, Bell Aircraft and Litton Industries are the two-axis displacement type gyro and we present trade arguments for their choice.

Ferd Hartmann's unique single-axis as heating gyro, developed by Arme Rüstung Aachen as an outgrowth of German gyro designs developed during World War II. Note Aachen has done extensive work on gas-heating gyros but does not disclose any details on its heated system.

In the area of accelerometers, the field is almost evenly divided between non-integrating and single-integration devices. Most systems using non-integrating acceleration also employ digital encoders which can perform the required integration function in addition to their other duties without significant increase in computer weight or complexity.

Smaller and Micro Accounts

A comparison of the weight of existing motor production with those earlier development tools reveals the significant net weight reduction that has been achieved in the past several years even though direct comparisons are difficult unless metric accelerators are known and comparable.

Isotopic systems of a decade ago weighed 1,900 lb., occupied 50 cu ft of space, had an accuracy of around 1 part in 1,000, and a resolution-to-noise ratio of only 50 dB according to Frederick Stevens of Nucleonics.

Toddy's inertial rocket weighs about 100 lb., occupies 3 cu. ft. space, has an accuracy of about one hundred yards and a mean-time-to-failure of about 2,000 hr., Stevens said.

An Air Force spokesman at Wright Air Development Center's Wright Guidance Laboratory estimates that slender has achieved a 10:1 reduction in initial inertia moment and weight in the past several years. He predicts a significant, but not quite as large, reduction in the next several years. But by then further gains will be difficult.

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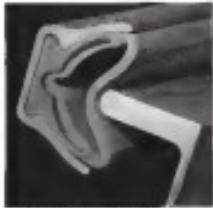
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CONVAIR 880 DOOR SEAL

Frontline military and service doors of the "880" airplane will be sealed under pressurized flight conditions by the Convair door support, self-emergent, self-diagnosing seal manufactured by CHR. This new seal is constructed of high temperature chlorosulfonated polyethylene (CSPE) with dacron fabric. An inner and outer pressure seal, a flexible frame provides a means of protection against the event of unanticipated damage to the outer pressure seal. The Convair door support is integrally sealed within the seal.

To eliminate the possibility of collapse, this flexible spring steel wire supports the side walls of the seal when pressurized and assures positive alignment with the fuselage skin. This unique design, not found in conventional door seals, was recommended by the unusual "180" plug type door structure.



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To achieve certain major achievements are aimed in developing fundamentally new types of gages and accelerometers.

This is one reason why the Wright-Patterson Guidance Laboratory is performing research in what it terms "basic" and "non-traditional" approaches. Convair progress includes investigation of the possibility of a microchip gyro at General Precision Electronics, a gyro with a size of 1/20th of a cubic inch. The microchip gyro program at the W. L. Marston Corp. Project in the General Precision Laboratory program has been "under way" since 1964.

One of the most challenging problems for imaginative engineers and physicists is to come up with fundamentally new approaches for testing or selection.

State-of-the-art vibration and acceleration testing equipment which engineer has designed for insects in a vibration similar to that of the head of a pin, may provide insight into basically new approaches for manufacturing inertial components and/or improving their accuracy. The vibrating gyro developed by Sperry Gyroscope Co. several years ago reportedly was designed by the NASA Goddard Laboratory (testing segment) of the convective boundary which are used to provide a form of gyro stabilization.

FUTURE Guidance Systems

Intertidal systems, in conjunction with various star/planet systems, appear likely to play the dominant role in interplanetary space navigation. Here, however, the inertial system's primary role will be to provide spatial stabilization for the star/planet tandem to keep them approximately aligned on the body.

Several major inertial system producers are developing referenced systems for such application.



Multivibrator

Microcircuit multivibrators, fabricated micro-fabrication, although already created, is one of several solid-state technologies developed by Texas Instruments (AWM Mar 1964, p. 15) in part of its molecular electronics program.

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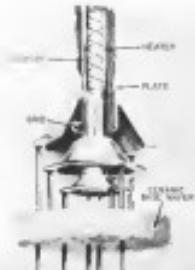


*Attitude system engineer,
M. W. Kasper, has 15 years
experience in electronic and
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development for space, ground,
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SCHEMATIC drawing showing Nuvistor construction is at left. That type of Novistor that RCA is presently developing are shown at right with conventional miniature tubes. They are (left to right) a small signal triode, small signal triode, and beam power tube.

Tube Designed to Compete with Transistor

By James A. Flanagan

New York's new design concept for electron tubes must broaden the competition between tubes and semiconductors. The design approach is to add features that will help the user of tubes that are more reliable and provide higher performance than conventional electron tubes.

Called Novistor, these new tubes are under development at the Radio Corp. of America's Electron Tube Division. At present these different tube types are being tested for simple devices like switch or rectifier, a small signal triode, a small signal triode, a small signal triode, and a beam power tube.

The design is the result of efforts by RCA tube engineers to beat the increasing encroachment of transistors in both the commercial and military markets. In addition, it also takes advantage of very fast performance in use and power density in a tube that can be more produced, coupled with increased performance and reliability, could compete in areas where transistors have certain inherent disadvantages.

Development History

RCA engineers describe the Novistor concept as the result of a general study and developmental program taking a new approach to electron tube design.

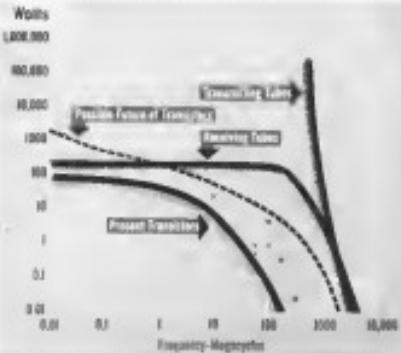
In the course of the program, planar structures, cylindrical structures, various spaced stacked structures, metal to glass rods, metal to ceramic rods, and similar structures were explored.

Planar tube elements because of the apparent ease with which they could be assembled, are not ones that we have fully investigated. It was found, however, that one advantage is simplicity because, via other advantages in electrical and thermal characteristics.

The concept of individualized structures for strong tube structures, however,

gained increasing support. It offered electrical and thermal efficiency and stability, and could be manufactured easily and economically.

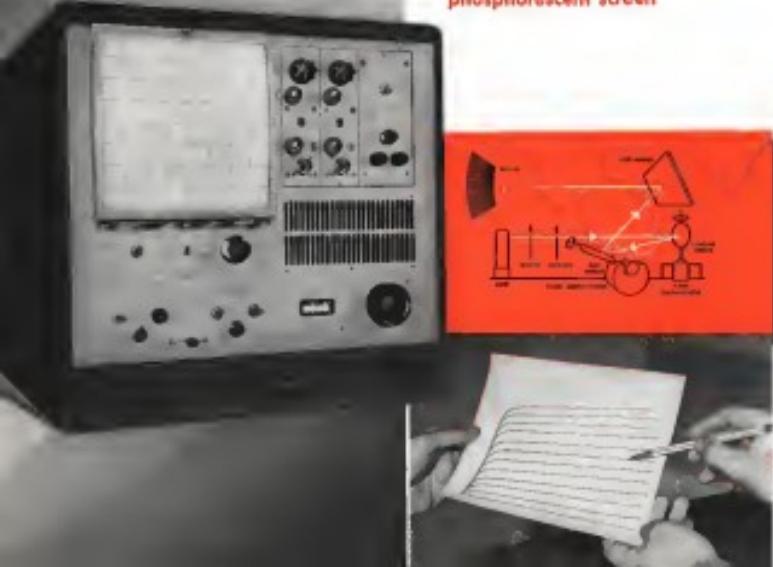
The designs that resulted from this study employ electron cyclotron resonance in an attempt to obtain maximum electron current. These cyclotron are held in place by fixed-like structures that are



POTENTIAL of electron tubes is compared with that of semiconductor devices at short wavelengths. Small curves represent performance of experimental transistors now being developed. RCA sees Novistor as a resulting area of competition between tubes and transistors.

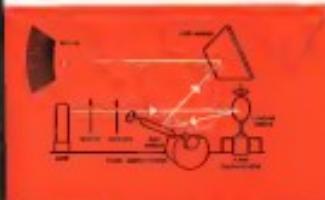
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TYPE	PODN (See chart below)	CESS (Same pod)	NEVOL
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-L.V.	-1V	-0V	-0.5V
15 ms	10 ms	7.5 ms	
12,000 mads	8,000 mads	12,000 mads	
Max. Pow. Consumption	1.0W	2.0W	1W
Capacitors:			
Input	1.2mf	3.0mf	4.5mf
Output	1.8mf	4.0mf	1.8mf
Grid-plates	1.4mf	0.4mf	2.8mf

OPERATING characteristics of Radio Corporation of America's Novistor are compared in table above with the characteristics of three more conventional types. Net Novistor plate voltage and plate dissipation.

mounted concentrically upon a ceramic base plate.

Conductor support for the electrodes consists of the lead used for strain support in strain gauges. All joints in the complete tube assembly are fused by a furnace at a temperature of about 1,300° F. and outgassed in a vacuum exhaust furnace.

The advantages claimed for this type of construction are:

- Cylindrical symmetry and stability of support of the electrodes provide a combination of high cathode efficiency and permit the use of premium gas for ionization.
- Use of heating instead of spot welding for joining materials removes a potential

source of failure and eliminates residual stress.

- Metal supports are not present to dry under vibration or interface with high temperature heating and exhaust processes.
- High-temperature degrading stresses many of the gases and supports that are difficult to remove during manufacture of conventional tubes in which glass and metal limit the operating temperatures. It also allows operation of the tubes at higher temperatures.
- Induced lag on the basis of the Novistor prevent damage to tube leads during insertion.

Design Considerations

When the electronic assemblies of an aircraft take are scaled down proportionally, some characteristics do not change, such as power, and others become power. For example, cathode efficiency and high frequency performance both improve. General operating characteristics such as mutual conductance and plate resistance remain substantially the same.

Cathode emission density, however, increases and the grid and plate operate at much higher temperatures. These latter effects tend to reduce tube life and reliability. Both of these effects can be offset if the electrode spacings are scaled down by a greater amount.

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400m	1W	12V	250mA	1.5W
400m	100W	50V	250mA	10W
600m	17W	100V	250mA	17W

CHARACTERISTICS and efficiencies of Novotube and transistor are compared above.

than the other dimensions and if more efficient thermal paths are provided the resulting losses are less.

This differential sealing makes possible the use of much lower electrical voltages thereby providing several advantages in addition to the corresponding reduction in power input. A wider selection of reduced voltage, and adjustable current, operating conditions is available because less energy is required to neutralize particles which might damage the electrode through ion bombardment. Another advantage is the reduced inductance required in the tube, tube circuit, and associated circuit elements.

Thermal Paths

Thermal paths in tubes are important. In the case of the cathode and its supporting structure, heat conduction is the major consideration. For maximum cathode efficiency, low thermal conductivity and low thermal resistance are needed. The grid and the plate, however, require paths of high thermal conductivity so that the grid can cool enough to avoid grid emission and so that the plate operates at a low enough temperature so that no electron emission occurs.

The effects of scaling down electrode spacing can be seen in the tube characteristics of the Novotube, and the re-

NOVOTUBE (left) and **TRANSISTOR** (right) for comparison.

NOVOTUBE	TRANSISTOR	NOVOTUBE	TRANSISTOR
Bias Volt.	5.5W	3W	—
Driver Volt.	4W	3W	—
Screen Volt.	12V	12V	—
Screen Current	15mA	15mA	—
Screen Voltage	12V	12V	—
Grid Bias	20W	2W	—

NOVOTUBE basic power tube is compared with conventional tube above.

NOVOTUBE	TRANSISTOR	NOVOTUBE	TRANSISTOR
Bias Volt.	1.0W	0.1W	—
Driver Volt.	0.2W	0.01W	—
Screen Volt.	0.05W	0.005W	—
Screen Current	1mA	1mA	—
Screen Voltage	12V	12V	—
Grid Bias	10W	1W	—

CHARACTERISTICS of Novotube are compared with conventional transistors.

of providing paths of high thermal conductance in the power dissipating electrodes.

Engineers at RCA's Electron Tube Division consider the advantages of electron tubes when compared with semiconductor devices. Since the Novotube is a deformable particle device, some of the advantages claimed are:

- Electron gun spacing, electron tube spacing is 50 times larger than the electrode spacing in a transistor intended for comparable performance. Consequently, tube spacings and the associated tolerances can be more easily controlled in manufacturing operations.
- Electrons tubes are composed in total cost, have high insulating and gain, and generally greater life expectancy associated circuit components.
- Novotubes are good at high frequencies.
- Electron tubes have a high uniformity of initial characteristics and do not require a costly selection process.
- Electron tubes are capable of handling relatively heavy currents and are less susceptible to radiation damage.
- Electron tubes maintain their characteristics over a wide range of operating temperatures.

Because of the electrical construction of the Novotube, RCA expects to be able to produce the tubes in large quantities and with a high reliability assembly. The tube elements are dropped into glass concentrically and held to the proper spacing by precision cylindrical glass bellows. The use of a cathode support sleeve to secure the active cathode makes it possible to heat the supporting structure before retraction of the cathode until which would be damaged by heat.

One other concern that is known to be working toward development of a similar type of very small, high-current electron tube is General Electric. Both companies are continuing their laboratories efforts to develop this type of construction with the rod cathode operation being studied by Ting Sui.



for temperature testing
in the laboratory
or in the place...

Constructed with the same glass as our standard temperature indicators, these pyrometers bring "start-stop" capability to the test engineer.



NOVOTUBE, left above, has been selected primarily for leading weapon and missile programs. For example, in the "Pershing" missile, Novotubes are used in the solid propellant motor. Elapsed time in reentry ballistic missile has been increased by 50% by using the Novotube. Many other missiles, both strategic and tactical, are using Novotubes.



MODEL 540 (left above) has seven temperature ranges for various applications. Range is 1000° F. 2500° F. 5000° F. 1000° C. 2000° C. 4000° C. 6000° C.

MODEL 541 (right above) has seven temperature ranges for various applications. Range is 1000° F. 2500° F. 5000° F. 1000° C. 2000° C. 4000° C. 6000° C. Standard design features, plus variable thermocouple inputs.

STANDARD PYROMETERS Model PAINTMETER. Ranges: 1000° F., 2000° F., 3000° F., 4000° F., 5000° F.

CENTRIFUGES Ranges: 1000° F., 2000° F., 3000° F., 4000° F., 5000° F.

Provided with either static flame methods or flameless methods and pressure balanced thermocouple inputs, plus variable thermocouple inputs.

THE LEWIS ENGINEERING CO.
Manufacturers of Complete Temperature Measuring Systems for Aircraft
HARWICH, CONNECTICUT

MISSILE
TRACKING

SEA-LAB



This huge antenna is part of an electronic and optical system that RCA installed and is operating on the S.S. American Mariner. The purpose of the equipment, for which the ship has been refitted, is to provide the most precise data yet obtained at sea on missile flights over a range extending from Cape Canaveral, Fla., to the area of Ascension Island. The project is

sponsored jointly by the Advanced Research Projects Agency, Department of Defense and the Army Ordnance Command. A scientific staff—most of them RCA personnel—will operate the equipment and report on missile performance from descent from space to final plunge, the data to be shared by all branches of the armed services.



RADIO CORPORATION of AMERICA
DEFENSE ELECTRONIC PRODUCTS
CAMDEN, N.J.

FILTER CENTER

► Maximizing Radar Detection—New technique which partially compensates for radar distortion of radar low-off-angle or pencil guidance systems has been developed by Ohio State University's Electrical Engineering Department. Technique been used recently in anti-submarine warfare systems being developed for submarine flight control system (AVM Feb. 6 p. 92). Project, headed by Fred Robert Coopert, is sponsored by Wright Air Development Center's Weapons Guidance Laboratory.

► National Telemetry Symposium—Call for prospective authors of technical papers has gone out for National Symposium on Telemetry to be held in St. Louis, Sept. 28-30. Papers are welcome on space vehicle communication systems, solid-state instrumentation, test planning and analysis, reliability analysis, A-100-380 wind tunnel and a 300-mm diameter should be submitted to May 10, to George L. Goss, Lockheed Missle Systems Division, Lockheed Airplane Company, Burbank, Calif.

► Field Emission Cathodes Ray Tubes—Possibility of using a field emission cathode as an electron source for a cathode ray tube has been confirmed by study conducted at Lawrence Radiation Laboratory under Wright Air Development Center sponsorship. Report is available from Technical Information Division, Lockheed P.O. 13216, can be obtained from Office of Technical Services, Dept. of Commerce, Washington 25, D. C., for \$1.00.

► Signed On Dotted Line—Major contractor awards recently announced by various government include the following:

• Tele-Dynamics, Inc., Philadelphia, will design a new high-speed system for early warning of incoming ballistic missiles to be constructed by Air Force Cambridge Research Center. New missile-calling "Telephones," will be able to transmit 10 frames a second which it passes over microwave facilities in ground line, the company says.

• The W. L. Marmon Co., New York, \$158,000 contract goes Bell Telephone Corp. for development of helicopter landing system known as HELLP (Helicopter Electronic Landing Path) for use in offshore operations.

• General Electric Defense Systems Dept., Syracuse, N.Y. Price contracts totaling \$110 million, for ground based guided weapons for Afar, from Air Marshal Command's Ballistic Missile Control Center cover work carried out under previous letter contracts.



MODEL IO-470-C
engine, used in Beechcraft King Air



MODEL IO-470-D
engine, used in Convair 880-C
bile engine executive airplane

WITH
CONTINENTAL
Continuous Flow
FUEL INJECTION

The engine using heated injectors from carburetor type aircraft engines vibrates when you fly with Continental Fuel Injection, for the refrigerating effect of vaporizing fuel at the carburetor is ended by eliminating the carburetor itself. With Continental Fuel Injection, no carburetor heat is ever required. You always use the coldest available air, for maximum power.

Add this gain in safety
to the new system's
other advantages:

...and you understand why
this exclusive system is
acclaimed as the greatest
flying advance in recent years
—why it is featured today
in the finest utility
aircraft in the world.

SMOOTHER
OPERATION

GREATER
ECONOMY

HIGHER
HORSEPOWER

FASTER
ACCELERATION

REDUCED
MAINTENANCE



Continental Motors Corporation
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AT TAPCO...

A unique combination of electronic, electrical and mechanical skills

Your project may require microwave subsystems and components. Or a complete ground support check-out device. Or servo-controlled subsystems and components for a whole new vehicle concept. On each of these the Tapco Group can design, develop, and manufacture your requirements on schedule.

The Tapco Group is experienced in the design and manufacture of electronic controls, including closed-loop servo systems and components, positioning controls, and small power-system alternators. Experience with microwave components includes coaxial and waveguide switches, power dividers, stripline microwave

Filters and microwave antennas

Air-vehicle electronic systems developed by the Tapco Group include highly creative electro-mechanical controls capable of maintaining the speed of rotating electrical machinery within plus or minus 1% in either parallel or isolated operation under widely varying loads, ambient temperatures, and vibration. Tapco-developed API speed controls provide an accuracy of one part in 100,000 (.0001%) under severe environmental conditions.

At Tapco you find an unusual combination of electronic, electrical and mechanical skills ready to serve you



API servo control system control and operation. Left: API developed and produced for 3000/4000 cycle surfaces air missile system. Right: API uses magnetron compressed magnetrons that are fully microstrucured today. Also incorporates unique Resonating generator for speed control.



ACCS, a MIL-STD-1553B interface converter and 1000V system, designed for automatic take-off control or flight control control for aircraft.



Three types of Tapco-developed wire-wound coilsides are used in roll, pitch and yawrate systems. (1) Unipolar current drive, feature of resistive wire-wound coilsides provides full wave-gauge power (2) three single pole, three-phase driver has interdigital resistors in series of 100 ohm (3) DC feedthrough wire gauge sensor has resistive annular resistors



Precision position and speed control in this Tapco-developed ground support unit combine programmed clockwise or counter-clockwise operation, highly reliable to advanced antenna positioning and tracking systems.



Advanced dual-SPM system, or software controlled dual SPMS, is Tapco's first dual mode solid-state subsystem. Tapco's Tapco-SPM, Tapco-SPMS, Tapco-SPMS-1000, Tapco-SPMS-2000, Tapco-SPMS-3000, Tapco-SPMS-4000, Tapco-SPMS-5000, Tapco-SPMS-6000, Tapco-SPMS-7000, Tapco-SPMS-8000, Tapco-SPMS-9000, Tapco-SPMS-10000, Tapco-SPMS-11000, Tapco-SPMS-12000, Tapco-SPMS-13000, Tapco-SPMS-14000, Tapco-SPMS-15000, Tapco-SPMS-16000, Tapco-SPMS-17000, Tapco-SPMS-18000, Tapco-SPMS-19000, Tapco-SPMS-20000, Tapco-SPMS-21000, Tapco-SPMS-22000, Tapco-SPMS-23000, Tapco-SPMS-24000, Tapco-SPMS-25000, Tapco-SPMS-26000, Tapco-SPMS-27000, Tapco-SPMS-28000, Tapco-SPMS-29000, Tapco-SPMS-30000, Tapco-SPMS-31000, Tapco-SPMS-32000, Tapco-SPMS-33000, Tapco-SPMS-34000, Tapco-SPMS-35000, Tapco-SPMS-36000, Tapco-SPMS-37000, Tapco-SPMS-38000, Tapco-SPMS-39000, Tapco-SPMS-40000, Tapco-SPMS-41000, Tapco-SPMS-42000, Tapco-SPMS-43000, Tapco-SPMS-44000, Tapco-SPMS-45000, Tapco-SPMS-46000, Tapco-SPMS-47000, Tapco-SPMS-48000, Tapco-SPMS-49000, Tapco-SPMS-50000, Tapco-SPMS-51000, Tapco-SPMS-52000, Tapco-SPMS-53000, Tapco-SPMS-54000, 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Patent Standards Laboratory at Tapco, where all secondary test assemblies are calibrated simultaneously. Tapco's ability to measure the integrity of electronic products.



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Our scientists and engineers can move rapidly on simultaneous, programmed projects. Analog and digital computers speed the design of electronic systems, then simulate their operation for test purposes. Components, electronic systems and subsystems designed in the TAPCO Group are produced within the Group.

Let us show you how we can design, develop, and manufacture electronic subsystems and components to meet your performance, reliability, and delivery requirements.



Production testing of microwave components at Tapco

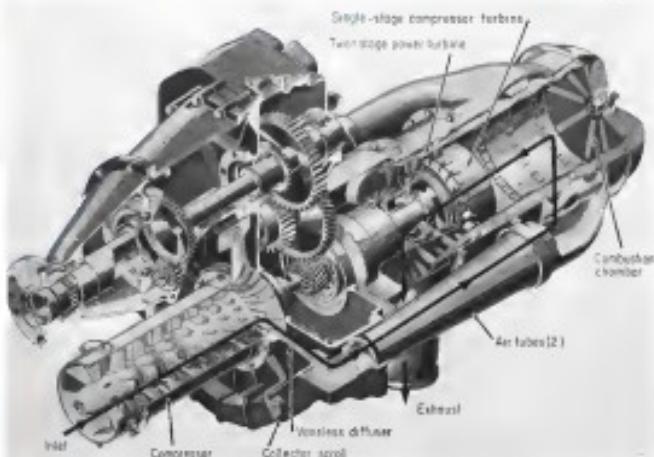


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AERONAUTICAL ENGINEERING



PRIMARY STRUCTURE of T63 is gas flow route which passes through elements, accessories and sections giving air inlet, Axial stage behind from compressor, pass through exhaust tube or side of engine and then a single thin stage combustion chamber.

T63 Designed for Low Cost Production

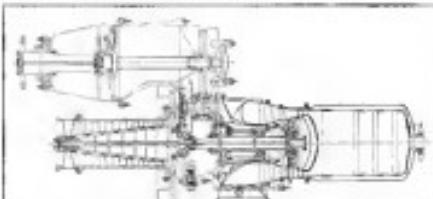
By Erwin J. Bellon

Concentric design approach is being combined with advanced materials, casting methods, Inexpensive use of Allison Division of General Motors Corp. on its new 230-shp T63 series of jet aircraft powerplants. Aim is to achieve low cost, light weight, simplicity and reliability.

Allison officials refused to discuss possible price for production—the company will only say that it expects to sell the T63 competitively with piston engines of similar power—but industry sources estimate that the new engine will sell for somewhere between \$15,000 per horsepower, in production quantities.

These same sources also say that an important factor in the cost aspects of the engine will be Allison's use of glasses for major assemblies of the engine, including the compressor section. These probably will not show up in

prototype models, but will be worked in during later phases of the engine's development. One cut seen in the center line of the compressor section. The seven axial stages can run on one gear, started in form a complete assembly, after their concentric buildup of a segment disk or disk and blades. These current metal ratings are expected to be translated to plastic



DOWNDRAFT EXHAUST in order of engine is clearly shown in cross-section. This is T63-A-1 prop-jet version, which reduces 6,800 shaft rpm to 2,800 rpm at propeller.

CASE HISTORIES



Photo Courtesy Bristol-Myers Laboratories
and Baldwin Electric Co.

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CUSTOMER PROBLEM:

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ment and production. N/D equipped micro-clock, selected by the Smithsonian Institute, now operating in 3 dozen locations around the world right now, keeping track of vital satellite movements . . . to accuracies of one millisecond and better!

If you're manufacturing or designing electric motors for any high precision applications, including instruments, why not call on New Departure? N/D engineering and research facilities are turning out the latest in high precision instrument ball bearings and advanced ball bearing designs. For more information write Department G-4.



DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONNECTICUT

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DESIGN PROBLEM in T-33 was developing best arrangement of gear sections and reduction, which bulk disproportionately large compared to power producing elements. Shows on-factory mockups of propeller-driven YT33-A (left) and jet-driven YT33-A5.

application in the later phase.

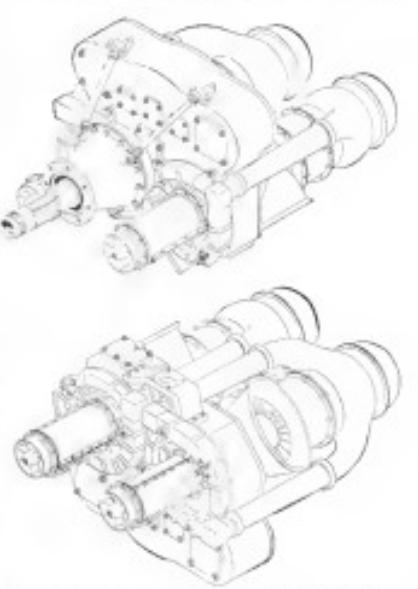
Two versions of the T-33 are currently in development for the U.S. Army. One version is being developed YT33-A1, and a dual-power version designated YT33-A1. Company model number is YT33. Allison states that it is not yet known specific installations for the propeller, but uses applications for both fixed-wing and rotary-wing aircraft, and also aerial platforms and drones. The company reports that its agreements with the Army provide for producing commercial versions of the engine concurrently with military schedules. In addition to being a prime mover, the YT33 is also very applicable to numerous other functions such as a helicot engine start, fire control programs and other possible projects.

Current progress calls for making the first run of the engine this spring, with tentative development schedules calling for 30 hr. test in the latter part of 1969 and completion of YT33-A1 and first production engines in late 1970.

Key areas of YT33 design research were covered by Allison chief project manager George Russell S. Hill during the Society of Automotive Engi-



REAR VIEW shows combination thruster (bottom) on T-33 nacelle.



TWIN DEVELOPMENT (Model 200) delivers 500 hp. Propeller-driven version is at top, dual-shaft type at bottom. Most components are of YT33; new gear reduction is used.



Barber-Colman Check Valves undergoing functional test

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AIR VALVES—A wide variety of check and pressure relieved air valves for compressor and pressurized applications. Normally, check, poppet, diaphragm, and exhaust air valve types.



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TEST EQUIPMENT—Compact electrical test sets for quickly checking all components of a Barber-Colman control system installed in an aircraft. Special units for checking aircraft fuel systems.



If it's Barber-Colman, it's better

**positive checking of high-speed air reversals
assured with these rugged pneumatic valves
featuring low leakage, low pressure drop**



1/2" Check Valve



2 1/2" Check Valve



3" Check Valve

Designed to check rapidly reversing, high temperature-high pressure air surges, Barber-Colman pneumatic check valves have been selected as equipment on many of the new jet airliners as well as military aircraft. In a typical application, the valve allows high temperature airflow into a wing thermal antiicing manifold from an engine compressor bleed port. When pressure downstream from the valve exceeds that upstream, the valve prevents reverse airflow.

At rugged, lightweight construction, Barber-Colman check valves have completed more than 10,000 surge cycles without appreciable wear. They pass 10 G vibration.

Pressure drop is very low. For a typical 23° seat, total leakage does not exceed 91 percent per minute for any combination of air temperatures from 80°F to 600°F and air pressure from 0

0 psig to 250 psig. For most combinations, leakage is less.

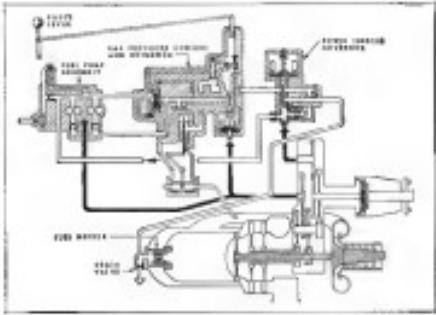
In addition to those illustrated, other Barber-Colman check valves can be designed to your requirements. Contact the Barber-Colman Field Engineering Office nearest you—New York, Chicago, Dallas, Denver, Los Angeles, Ft. Worth, Boston, Montreal. Or write direct to our free Barber-Colman air valve catalog.

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CHECK VALVES



Pratt & Whitney aircraft/hydrazine engine control system elements: electronic components, namely, constitute the pilot or the computerized mechanism for necessary functions.

engine controller—into the single combustion chamber which is placed around the compressor turbine shaft. Each burner chamber is at the aft position of the engine; hot gases move forward from the combustion chamber through the turbine vanes and enter an exhaust

heat exchanger located in the middle of the engine and are then exhausted downstream.

Main structural element of the TS3 is the gear box casting. The compressor assembly is bolted to the forward part of the gear box and the turbine reduction gear is bolted to the rearward part of the gear box, thus forming a compact, vibration-free assembly.

is bolted to the aft face. The gear box contains the spur gear train which engages a small gear on the power turbine shaft and transmits output power vertically upward to the main shaft above the engine's rear end.

Output shaft rotates at 4,000 rpm. A planetary reduction gear set, having proportionate ratios, is used. For mounting a propeller shaft, one can be attached in the forward face of the gear box engaging the 6,000-rpm output shaft and developing output power of the engine to the propeller hub at 2,000 rpm.

Gear Train

A spur gear train is included in the gear box, engaging a gear on the power turbine hub shaft, to provide connection to engine accessories pads on the gear box.

With the complete compressor assembly and turbine-compressor assembly bolted to the gear box, each in the same manner as in the static, generator, fuel control and propeller reduction gear train elements, can be removed and replaced about the same time as the turbines, Bell noted.

In addition, the engine arrangement leads itself to nose configuration producing 380 shp, he reported. Design studies have been completed. Testing is accomplished by using a new gear box casting providing for maximum



RELIANCE II 800
aircraft power model 2070-0-0

SOLID STATE
converted model 1870-0-0



10/10 INVERTER
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AVIATION WEEK, April 4, 1989

T63 Timetable

Mar. 15, 1989—Initial proposal for Model 150 (T63) presented to nuclear version.

Spring, 1989—Test compressor built and run.

June, 1989—After review T63 design equipment contract.

Nov. 15-20, 1989—Testing review conducted to establish production configurations for propeller drive and helicopter for wind.

Early spring, 1990—First use of engine reported.

ing of two compressor and turbine sections and a propeller reduction gear capable of handling the doubled power output. This configuration of the T63 is designated Model 352.

In the T63, switching of compressor and turbine compressor has been done to favor cruise performance. Mach point of the propeller, represented by full output pressure ratio and mass flow rate as could be plotted, placed off the maximum efficiency ratio of a power turbine map so that these points will be on the maximum efficiency line. This approach results in optimum specific fuel consumption. For the lower cruise power at a reduced power, a maximum power is

Compressor Design

Selected values of 6.2 pressure ratio and 3.0 lb/sec airflow represented a compressor design problem at the beginning of the project well established art, according to H.H. Hall. Small size, high speed, low Reynolds number and high pressure ratio in combination represented no easy way when there was a lack of adequate compressor data, he noted, without purchase of compressor performance curves.

The most economical configuration was determined for the final low pressure ratio of 1.2. The benefit of a low efficiency allowable compressor was the centrifugal type and the difficulty of obtaining a 1.2 pressure ratio with the latter configuration of such small size.

With the Rotorflow machine being of extreme importance in the design selection of compressor hub to be used to provide blades with large chords, passage with the greatest possible speed between blades and with great radial depth while maintaining blade aspect ratio as high as possible.

Centrifugal compressor was selected for the last stage. Despite the very low MPR to ratio selected to maximize the Rotorflow machine availability, the final stage fan wheel module, the final stage centrifugal type, impeller can be used to replace it at least three serial stages and because of the centrifugal



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Here, the problem was 3-fold: (1) Develop a flexible coupling for automated hookup; (2) Prevent leakage; (3) Protect vital internal parts from slag.

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(5) Keep weight to a minimum.

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form along the flow direction in much better suited to handle the well-defined speed boundary layer. Hall noted. Also, due to the loads placed on the position of molecules in such a small gas-phase, compression must be balanced at a small price so as to prevent the compressor from being damaged. A centrifugal type motor can be designed to use the space required to deliver air to collect the load and reduce compression.

To avoid undesirable still efforts, the centrifugal element of the compressor was finally designed with a stainless steel type diffuser.

Engage control system is simplest possible mechanical/hydraulic type or logic or the pilot valve possible and eliminating components completely. Pilot will control the engine by monitoring a turbine gas temperature indicator in event of over-temperature operation on the engine. The pilot would adjust the throttle setting to bring the temperature within limits. A torque indicator would be utilized in the pilot to avoid damage to the engine. The torque could run to 1500 rpm normally. It is allowed to go to full rated temperature.

Helicopter rod drives would provide connection of pilot's lever to the power turbine position to prevent selection of helicopter rotor speed. Normally, the lever would be moved to the maximum speed position so that the generator sets as an over-speed protection device. Once under this setting the power generator would first return over the load control function, the gas generator will increase its discharge rate to demand.

PRODUCTION BRIEFING

General Electric Co.'s Jet Engine Department, Cincinnati, Ohio, has received an \$8,000,000 Air Force Contract for further development of the J75 derivative engine.

Turbo Dynamics Corp., Los Angeles and Pasadena, Calif., has completed an ordering of Subscale Engineering Co., College Park, Md., as its subcontractor to its program of expansion.

Martin Co. has received a \$7,400,000 USAF Air Materiel Command contract for expansion of the TM-708 Master.

General Electric Co. has been awarded a \$1 million National Aeronautics and Space Administration contract for development and delivery of a liquid propellant rocket engine to power the second stage of the Thor-Agena vehicle (AVN Note 1, p. 18). This will be a further development of the Vangard-Intergal powerplant with an greater thrusts designed for repeated starts at high altitude.



Testing the hot air test facility for rugged-CEC Pressure Package... the 4-316A and 4-317, both designed for a wide range of pressure measurement at extremely high temperatures. Hundreds of these unique packages were used to measure the dynamic and static pressure differences across the intake of the Convair 120 during the initial powered flight of the first F-106 aircraft.

Designed for continuous operation at 600°F. without cooling, the 4-316A and 4-317 cover a pressure measurement range of 15 to 5000 psi gage. Among their features, one-piece construction was chosen from 416 stainless steel .016" and 1/16" internal diameters, .015" weight at 35 and 25 gages with measuring fixtures. They are widely used in flight-test, vibration studies and supersonic tunnels. When external cooling is practical, an unique method of operating ranges of 4-117 to 2000°F.

For additional information, call your nearest CEC office and carrier office or write for Bulletin CEC 1381-R23 and 1381-R39.

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Front formation shot shows MiG-21 (NATO codename Fishbed), latest Soviet design in Mikoyan series. Single nose air intake and large tailpipe suffice although twin tail is



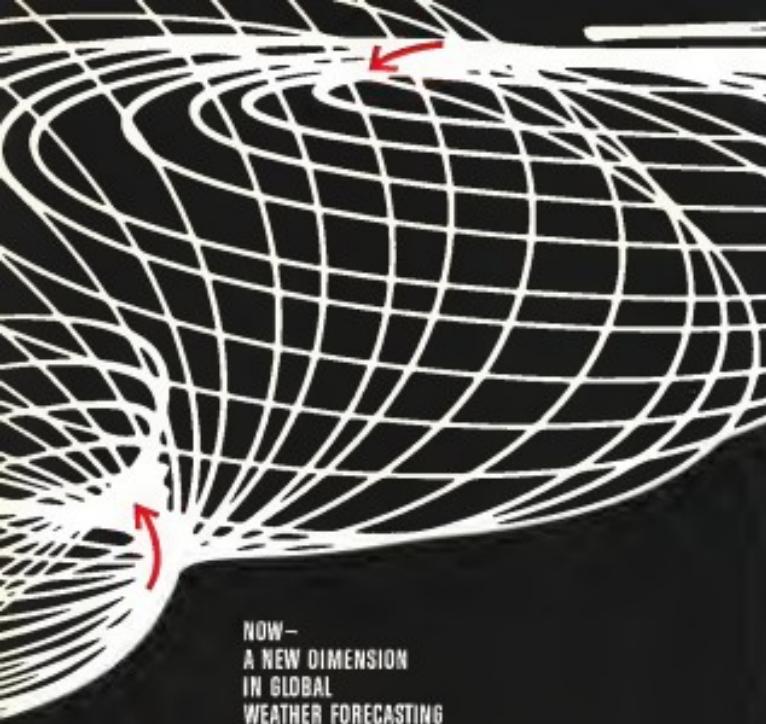
Formations

MiG-17 (NATO codename Fresco) formation (left above) shows modifications added to later models including addition of control fin on rear fuselage, revised heat-treated sword profile on rear fuselage, where also better for the configuration this model based on the Rata-Ryazan design it has had, and landing leg fairing tail, possibly housing afterburner engine controls. Seats 37 min., canards pivoting just below seat assembly on nose, external fuel tanks, and three wing fences to improve airflow over highly swept wing. MiG-17 is now standard operational fighter for Soviet strategic bombers and is being phased out of Soviet Air Force fighter units. Top speed is about 700 mph. Clean-up air-to-air photo (left) of MiG-19 fighters shows switch to lower horizontal stabilizer, inverted tailfins for three-engine installation, single large wing fence.

Show Design Details of Operational Soviet Fighters



Scramble takeoff it made by MiG 19 (NATO codename Farmer) at an operational Kubinka airfield. Note leading gear struts and relatively small tailplane diameter as contrast to main fuselage diameter. MiG-19 is now standard fast low Soviet Air Force fighter with top speed around 1,000 mph and service ceiling of 40,000 ft. MiG-19 has combination of old-fashioned used sections and modern skin sections on fuselage. Aircraft has two small diameter, high thrust variable-sweep wings of about 0,050 lb. thrust each, dual air intakes and tailfins



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JETT jet engine in the U.S. operated solely on nuclear power was the General Electric X-18, a modified J17. Main modification is the two units replacing the combustion chamber to draw air in and from the nuclear reactor located at the side of the engine.

Part II: Nuclear Aircraft Program

Scientists Aim at Nuclear Plane Test Data

By J. S. Butz, Jr.

Washington—Feasibility of the power systems and the basic design approaches needed for construction of a nuclear-powered aircraft has been clearly established during the eight years since applied research and development work was started in this field within the U.S.

Available data coming for these nuclear aircraft systems has been gathered primarily by experimentation and testing rather than through the development of exact theory which could be used to design the system required for an aircraft under consideration. Findings are that nuclear reactors will not compete for space, weight, cost, and that nuclear aircraft design will be largely an empirical matter just as the design of conventional aircraft is today.

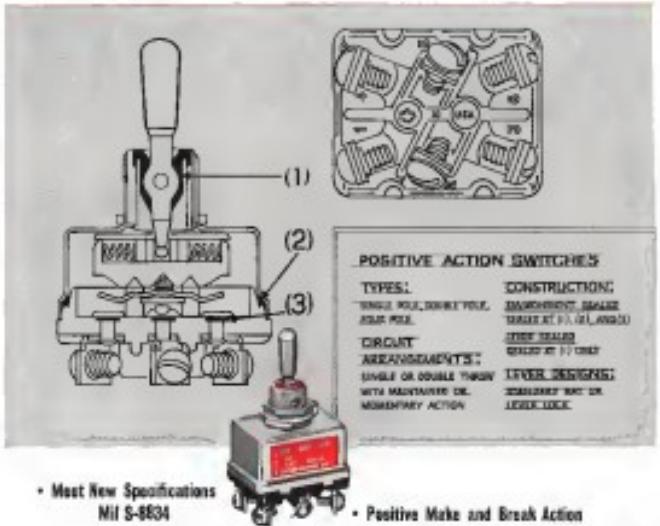
W. E. Edwards and J. E. MacDonnell of General Electric Co., in discussing shield design in a recent technical paper, said, "Exact methods of shield analysis are not yet available. Perhaps computing machines available now or at least those available in the future will bring exact methods into the realm of feasibility. Even then, the accuracy of the methods will depend on the quantity and quality of basic data available."

So many variables affect these basic data that most authorities agree it will not be possible to develop exact shield design techniques for a number of years. However, Convair, General Electric and Lockheed, the three firms who probably have done the most work on the aircraft shielding problem, agree that it has been proven that empirical methods are adequate to produce shields



BURRME until a typical of those which have been used on the several dash numbers of the X-19 which have been tested. Aeronautical view through intake and engine is visual.

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*** Wiping Contacts Insure Positive Performance**

contents make and break independent of one another.

This section has a title, *What's New*.

extracts ends and break independent of any spring pressure. These switches have positive detent action—they cannot be tensed.

A new insulating material provides improved arc-tracking resistance and excellent voltage recovery. Staggered terminals permit maximum clearance for easier wiring. Circuit arrangements are unlimited. Available with either standard toggle lever or new lever lock. Write for Publication EA-165-G-284. Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

light enough for use on passenger aircraft which gross around 300,000 lb., may carry larger payloads than conventional aircraft of the same size and allow greater than current utilization of flight crews.

Similar statements have been made about the adequacy of present surgical drug methods for the other outcome scores for a single arm trial. The tree required to build and fit the two reference survival curves using these methods is estimated by Abigail Ewing, Christopher and Alan Tsoo, founders of *Susceptible*. Section three and five pages (AW Alt 30 p 85).

Completion of pupil placement on market aircraft shows that many of the flight approaches to these five critical problem areas already have been nicely filled.

- ## **Review and critique: Teaching Materials**

General Sampling and Examination.

types of nuclear families in the panel.

countries visited on the U.S. in the desert

the engine is passing through

It's easier to meet the customer as well as the supplier.

to provide similar. This type of plant has been in development for eight years by General Electric, which has a classified \$47, disengaged the \$39, for 100 hr. on nuclear power.

Several motors have been run in combination with various draft numbers at the X-30 during its General Electric experiments at the AEC test site at Idaho Falls, Idaho. The motors had all been placed to the side of the turbine so that considerable voltage was necessary to connect the 147 to the system.

This problem was the much higher pressure drop through the reactor and its connecting piping than had existed on the turbine using a chemed dual burner section. This left the compressor and the turbine in a both unsynchronized condition. To solve this problem, initially, the compressor was modified to supply less air than in the original design.

Two rods also will be required, one to hold the compass arm so the best reading can be made, and one to send the arm back into the ambita. These rods are approximately $\frac{1}{2}$ in. diameter, square, wooden, ten-poled compasses, and the two least used poles are used in vibration analysis which have not yet been tested. Dimensions: Model testing is the only design specification given for these tools.

The next section will



FEATURING the "Headlynes" manipulator, project engineer Ralph Melton places his hands over each pair of pants as his fingers, giving him a "feet" for each leg he is performing.



UNREPUTABLE: capabilities outside capacity (above). These dimensioned risks TV causes allow more atomic control over mechanics, a risk to death to control. This leads to "unreputable" behaviour.



The logo for Cutter Hammer, featuring the company name in a stylized font above the words "POWER TOOLS".

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visible here—and that is that:

Three power to the
day from the breaking of ground
at Martin-Denver, TITAN No. 1 roared
into the sky. These 18 missiles
are the creation of the free world's
most advanced ballistic missile
factory—and the development,
production, testing, delivery and
launching of the first of an entirely
new generation of ballistic
missile weapon systems, furthermore,

of the Global Strikeforce.

TITAN is the
result of an advanced engineering
concept—developed by Martin under
the direction of the Air Force's
Ballistic Missile Division
of the Air Research and Development

Command—which provides the
most extensive pre-flight testing of
components, subsystems and full
scale interstage fairings undertaken.

This method in
the TITAN development,
and in the generation of space
systems to follow, may well
be one of the most important single
factors in speeding America's
bid for space supremacy.

that's why is their tendency toward
severe pressure distribution and high
temperature spots.

Design of small high power density
radiator such as the type needed for the
nugget concept is involved and dependent
upon a number of variables. Basically,
the overall radiator being developed
today is about 4 ft. diameter
and approximately 4 ft. long.

This must be kept small in order to
reduce shielding weight. Larger power
radiators are necessary at highest
possible temperature and require heat
transfer between the radiator and the
engine air.

Rad elements and their placement in
the radiator must be handled with great
care if the efficiency of the system is
going to be high enough for flight use.
The power distribution across the radiator
can and the nugget elements should
be very even, and, logarithmically, it
should be peaked toward the forward
end of the core to get the maximum
efficiency.

Two general methods have been used
to achieve these power peaking—adjusting
the plenum size and the location of fuel
in the radiator elements and varying the
spacing between the elements.

The air spaces between the fuel ele-
ments greatly complicate the job of
determining the efficiency of the system,
because they are separated by air spaces
and, therefore, insulated cold shielding.
This also limits the use of the
critical mass. Radiation also tends to
leak out of the system in the air
spaces and upset thermal calculations
to determine the emissivity and metas-
tasis of the radiator.

Used types of metal materials have
proven to have mixed blessings for
radiators. Graphite which is a good material for certain applica-
tions gives a very bad power peak in the
radiation field at a heat exchange
surface. This can only be corrected by

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SCHEMATIC of the test rig for operating
high-voltage power supply has the motor
in very large vessel with much more shielding
than is needed for the dissolved cooling
needed in an aircraft.

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Republic Aviation Corporation has the complete systems responsibility for the Swallow development, working in close cooperation with U. S. Army Signal Corps Research and Development Laboratories at Fort Monmouth, N. J. and the Army Combat Surveillance Agency, Arlington, Va.

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CERAMIC coated sheet materials are used in reactors and high temperature reactors, similar above. Work with such materials proves the feasibility of elastomeric equipment in controls over reactors

an improved adjustment of the fuel distribution.

Control of the reactor and its turbines will be simplified, according to General Electric, so that the pilot of a nuclear aircraft will have powerplant controls similar to those on a conventional jet engine. The reactor will have a number of control rods which will be carefully withdrawn during the starting period. Starting period and power will be automatically controlled and metered.

Power Control

After the start, the power curve will flatten out for most reactors and after rapid changes in power will be slow. Though these power changes will not be quite as great as that possible with chemical fuel reactors, probably will be as great as the engine's starting machine can take. The new electric magnetron, solar, surge, etc. Acceleration characteristics at the reactor are such would then be somewhat worse than those of present day reactors.

Several automatic systems and their necessary sensing elements which can make it possible to manually or by remote control of the reactor system have been studied at length by General Electric. Basic components of these systems are automatically controlled elements or rods thermal, or neutron sensors and actuators. All of these components will have to function in a high radiation field over the reactor and, during the start up period, it has been suggested. General Electric feels that improvements can be built with a satisfactory service life.

Probably three sets of automation will be necessary to prevent damage to the nuclear actuator of the reactor. The first will be needed during the starting period when the neutron activity is small; another will be needed at the end of the starting period when rapid power changes are taking place; the third will take over when the reactor is at the power step and needs flight for flight.

Automatic systems which will be used

to control the nuclear powerplant from non-man functions—to keep the power level of the reactor nearly equal to the demand level and to keep the multiplication factor at approximately one. The multiplication factor also is called the reactivity. In a reactor, the heat and power of the control rods which set the rate at which power may be increased. When a reactor is used in conjunction with a turboprop engine, this multiplication factor must be made to stay for rapid increases in power can not be matched by sudden high increases in the air flow needed to keep the reactor at its prescribed operating temperature.

Flight Monitoring

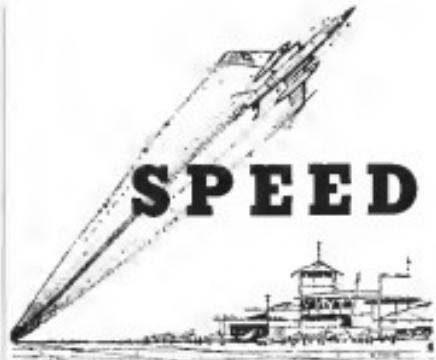
On the nuclear aircraft if it is well planned, the flight engineer will monitor the reactor constantly so that he can manually take control in the event of a failure out of the automatic control. It has been determined in tests that both the automatic and manual systems are practical.

The only airborne shielding development work conducted in the U.S. thus far has been handled by Convair. A 1,000 kw reactor was down in a modified B-52 designed so that it was possible to evaluate 16 different combinations of shielded shielding. Tests showed that one of the best tools for reducing shielding weight is to divide it between the reactor and the flight crew's compartment.

To 16 methods were selected by shielding consisting of layers of rubber and lead. The lead thickness varied from .35 to 2.5 in. and the rubber from .35 to 17 in. Glass fiber plates were provided which were 1 in. thick and about one-half in. to 11 in. thick and formed from Phenolic and leaded glass. During the flight crew compartment there was a half-scale crew shield which could be moved in compartments. Be-



DAC RIDGE test setup shown was used to simulate a complete jet engine and determine the nature and life of control rods and the length of the cooling period necessary before duct maintenance could be performed. Reactor is at level of right



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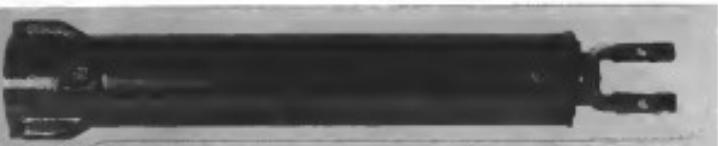
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with respect to finish requirements and material for the barrel. The operating pressure is approximately the same and so is the expected service life of five years, or 300,000 cycles. Generally these cylinders may be serviced for additional use by merely replacing the seals.

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SHELLY Ingot process, according to General Shiley, left; to allow close view of reader and tulipite in operation

than this multi-bladed eye, compact seat and the reader, it can possibly be by several varieties of shadow shields. These small shadow shields augmented outer shield turns around the reader. There were nine of these shield turns which could be filled in various combinations.

Postural value of this airborne test seat was to exclude the effects of air currents and airframe reaction on the reading patterns from the reader. At 40,47 flight was made with this instrument in its original attitude. This occurred in March, 1957.

Further, no attempt to determine the effects of the reduced gravity produced by the release of the B-52 were conducted here at Clark Ridge. Thus, the test reader and the eye compact seat were suspended from 100'. It turned in the same relative positions they had occupied in the aircraft and the seat of shielding arrangements were tested again.

When the shielding is placed near the reader, it will hit to the point where ultimate reading passage will have to be provided in the shield to keep it sound over a long period of time.

In general, shield design begins with the writer of the reading done to the level that will be allowable of the reader and that which can be permitted to reach the focus part of the airborne. Adjusting the angle of the shield around the reader and the reader will restrict these designs.

It was found through the Cessna flight tests and through ground experiments that generates a set of the most important design parameters for effective shields. Through gamma control at his power possible to tie the aircraft structure around the reader to give advantage in reducing the load of the radiation reaching the eye, compartment and other portions of the air craft structure.

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OPERATORS control of the shielded room because they at Idaho Springs can never hear noise and perform all but the most detailed work on jet engines. They would then dimension pulse telegrams for the detailed operator.

engineering accomplishments. Their include:

- Heavily shielded shop 80 ft. wide, 160 ft. long and 60 ft. high. Operators work directly through shielded windows since feet float. These operators accomplish gross assembly and skills of equipment within the shop through the use of large manipulation mounted on the walls and on an overhead cart.
- Full three-dimensional vision televisions developed in the world, according to General Electric. These cameras make it possible for an operator looking at the shield to get a close up picture in depth of the same vacuum equipment required in the assembly and disassembly of engines. It also makes it possible to see internal engine cooling ducts, piping, ducting and fans on the jet engine.
- Manipulators which allows the operator to feed the tools and parts that he is working with 20 ft. in any radius of the shielded shop. The operator controls the manipulator by placing his hands in gloves which exert pressure on his fingers to move these manipulators. The pressure is converted into the movement on the engine parts.

- Monitors which allows the operator to feed the tools and parts that he is working with 20 ft. in any radius of the shielded shop. The operator controls the manipulator by placing his hands in gloves which exert pressure on his fingers to move these manipulators. The pressure is converted into the movement on the engine parts.
- Monitors which allows the operator to feed the tools and parts that he is working with 20 ft. in any radius of the shielded shop. The operator controls the manipulator by placing his hands in gloves which exert pressure on his fingers to move these manipulators. The pressure is converted into the movement on the engine parts.
- Shocked locomotive weighing 710



AMERICALLY MADE GAUGE TO STAND OIL TEST This unique device checks torque of RAM-Lindsay pressure drops on the 1959 force pounds (lb.-in.) range, available 610 to 1600. Dynamic temperature is 6200 rpm. The test is conducted at 60° F. Periodic safety inspections are made with sensors reduced to 50°F after operation and

THE RMC-LINDSAY GAUGE IS RADICALLY DIFFERENT from ordinary high pressure gauges

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4. No other gauge can match RMC-Lindsay specifications.



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The RMC-Lindsay gauge solves them. **TOOLING** Standardized tooling prevents losses of 20 hours the amount that usually requires custom built tooling. **TEST EQUIPMENT** One RMC-Lindsay unit replaces five standard test equipment units. **TEMPERATURE** One RMC-Lindsay has seven certificates of accuracy for temperatures from -40° F. to 1600° F. and can measure vacuum vibration rates at 60, 100, 150, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1100, 1200, 1300, 1400, 1500, 1600, 1700, 1800, 1900, 2000, 2100, 2200, 2300, 2400, 2500, 2600, 2700, 2800, 2900, 3000, 3100, 3200, 3300, 3400, 3500, 3600, 3700, 3800, 3900, 4000, 4100, 4200, 4300, 4400, 4500, 4600, 4700, 4800, 4900, 5000, 5100, 5200, 5300, 5400, 5500, 5600, 5700, 5800, 5900, 6000, 6100, 6200, 6300, 6400, 6500, 6600, 6700, 6800, 6900, 7000, 7100, 7200, 7300, 7400, 7500, 7600, 7700, 7800, 7900, 8000, 8100, 8200, 8300, 8400, 8500, 8600, 8700, 8800, 8900, 9000, 9100, 9200, 9300, 9400, 9500, 9600, 9700, 9800, 9900, 10000, 10100, 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that resist nuclear radiation

Positive and reliable communications are the lifelines of new strategic weapons, hypersonic aircraft, satellites, and air defense. Resistance to nuclear radiation damage is an additional prerequisite for some of these advanced weapon systems.

The Bendix Systems Division, among the Ford Nuclear Reactor at the nearby University of Michigan, is developing radiation-resistant Mission and Traffic-Control equipment. This work is being conducted by Bendix as a contractor to the Air Force. The objective is an M&TC subsystem providing extreme reliability under severe environmental conditions and over long operating periods.

Hypersonic aircraft and re-entry vehicles require that communications overcome the obstruction of surrounding ionized air. Bendix is carrying out

propagation investigations and experimenting with designing special digital and voice communication systems. This work is under way at the Systems Division, Radio Division, and Pacific Division of the Bendix Aviation Corporation.

Positive communications also require resistance to jamming. Advanced research at the Bendix Systems Division has evolved techniques that combine jamming resistance and security of transmission.

Advanced communications know-how is being applied to additional programs for which the Systems Division has system management and engineering responsibility—such as the Navy EAGLE System and the Air Force AN/AMQ-15 Weather Reconnaissance System—and is applicable to many others.

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For more information please write to Mr. A. B. Stevenson, Engineering Personnel, North American Aviation Inc., Los Angeles 45, California.

THE LOS ANGELES DIVISION OF
NORTH AMERICAN AVIATION, INC.

AVIATION WEEK, April 6, 1959

tions and carrying 32 passengers, used to transport the test rigs to White Sands, the test area two miles down the track to the discarded test aircraft ship. The launching probe would be used to transport a nuclear bomber after a flight from the end of the runway to a large enough maintenance hangar. The aircraft would be run up on a low flat car on tracks and then pushed by the launching probe.

Two major remote handling areas would be the usual operation of a nuclear aircraft have been designed but not constructed. They are:

- Large remote banner with shielded probe for removal and storage of highly radioactive atom and normal radioactive materials.

- Spherical-shaped, shielded vehicle with manipulator arm to perform many of the required tasks and disclosures of the reactor and attending equipment just after landing. This vehicle would be very heavy because it would carry 75,000 lb of lead and should stand against gravity solution. Neutrons that becomes extremely small in mass as the reactor is shut down.

Long Utilization

Prestigious mission with long utilization comparable to commercial aircraft and much better. Two million exposure hours in the past is being predicted for the ultimate nuclear aircraft in that flights will last approximately one year and that each about 15 a year must have to be made to work this effectively.

Pat exposure data also shows that systems on the nuclear aircraft probably will be more reliable than those on conventional aircraft because they will operate under steady state conditions for much longer periods. Failure rate of complex mechanisms has been shown to be dependent on the number of operational cycles performed rather than the number of hours of steady state operation.

Most intricate facility for the experimental material needs of the effects of nuclear radiation on aircraft materials was recently built and opened for the Air Force by Lockheed in the North Georgia mountains. This facility allows the simultaneous irradiation of one million cubic inches of material. A large aircraft has been placed on a sledger so that it may be moved from its normal position at the bottom of a shielded pit filled with water to irradiate the test aircraft. After this has been exposed for the proper length of time the reaction is lowered and the infrared cameras are automatically released so that they will roll away to a safe location where they can cool off and then be transported by normal means to an X-ray station kilometers 2-3 km distant.

Primary concern of the materials



COUNTER-MEASURES ENGINEERS

Work on America's most advanced weapon systems at North American Aviation, and leading progress in the field of space exploration, has created unique opportunities for oriented engineer elements with a tremendous engineering potential.

We have immediate openings for specialists and systems engineers in the field of electro-magnetic and nuclear counter-measures. Specialized areas include basic noise transients, wave noise analysis, receiver techniques, system logic, interference systems design, and antenna theory and antenna development. Participated engineers are needed in several areas mentioned. For counter-measures systems and to evaluate new components and linkups and their application to advanced systems.

Minimum requirements are: minimum requirement is a Bachelor's degree in EE or Physics.

For more information please write to Mr. A. B. Stevenson, Engineering Personnel, North American Aviation Inc., Los Angeles 45, California.

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work, which has been done to date is that it will be possible to build a submarine nuclear reactor from existing materials if they are judiciously used. Degradable materials are most affected by radiation because they are damaged by both neutrons and gamma rays. Both of these types of radiation, which are the major types coming from a fission re-

application of a 10% linear black and white coloration pattern. Adder claims are also made for a color television system having a color television receiver and a color monitor. The monitor has a color television screen and a color television camera. The monitor is connected to the television receiver by a cable. The television receiver has a color television screen and a color television camera. The television receiver is connected to the monitor by a cable. The television receiver has a color television screen and a color television camera. The television receiver is connected to the monitor by a cable.

conditioning programs for CP-100 and 20-40 strains. (PPS 30-3-104-2014) and PPS 30-3-104-2015) and a corresponding W-11 (PPS 30-3-114-2115) and W-12 (PPS 30-3-114-2116) were also issued. W-11 and W-12 were issued on April 10, 1964.

TYPE INSTRUMENTS, Inc., Dallas, Tex., has been granted a U.S. patent for its work in reducing and conserving energy production by reducing the heat generated by electrical power systems. (PPS 30-3-104-2016)

PPS BUREAU 442-12, ETS-120

PPS BUREAU 442-12, ETS-120
The revised association and liaison section of C-115 (PPS 30-3-104-2017) and PPS 30-3-104-2018) was issued on April 11, 1964.

TYPE INSTRUMENTS, Dallas, Texas, has been granted a U.S. patent for its work in reducing and conserving energy production by reducing the heat generated by electrical power systems. (PPS 30-3-104-2016)

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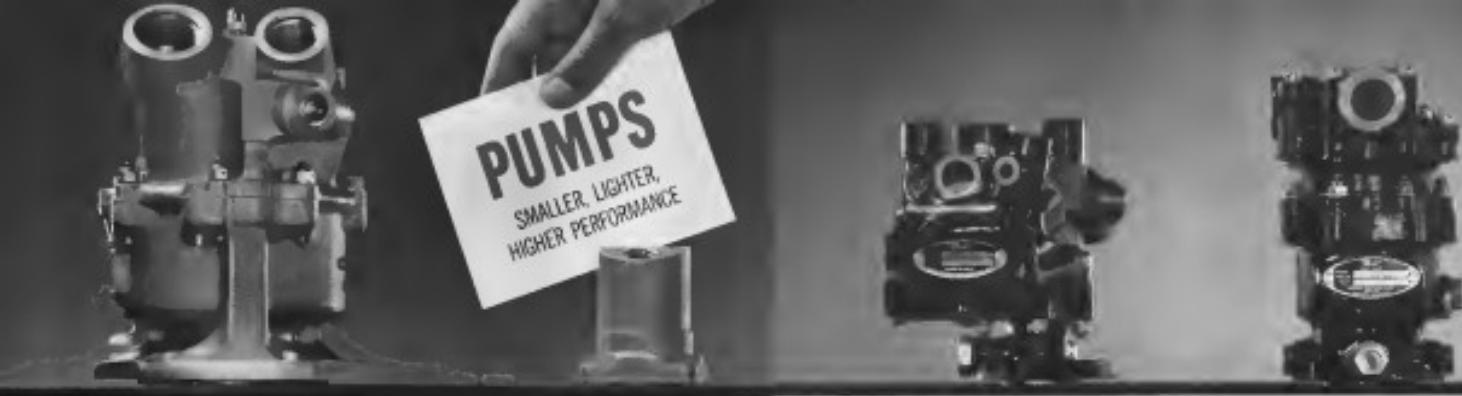
Johnson Avistone, Los Angeles Division,
manufacturers of the X-18 Aerodyne
series hangar temperature building.

+1200°F as reported at that "black phantom" reaches the entry phase into the earth's atmosphere at hypersonic speeds. The R-10 testbed is expected to withstand these extreme temperatures and go deep into the innermost level of the heated possible state.

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Belows and bellows assemblies for aircraft and missiles, vehicles and other precision instrumentation tailored to your needs. Originally developed to meet the exacting requirements of aircraft and missile components bearing



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Makes for dip brazing techniques offer freedom of design. Wrought,

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Stand to reason... here's an airplane so far advanced in features and performance, yet so sensibly priced, that it's sweeping the market. Public enthusiasm for the sleek, beautiful Comanche is far ahead of the most optimistic expectations. In nearly every standard of comparison, sensible, clear thinking analysis shows the Comanche has far and away the best combination of features. Nothing compares with it, on a dollar-for-dollar basis. In the renowned 180 horsepower Comanche (\$14,995) you find performance equal to or better than any all-metal four-place plane in its class and you get it with far less fuel consumption, much lower all-around operating costs. In the fabulous 230 horsepower Comanche (\$18,995) you climb 1400 feet per minute... cruise in honest three miles a minute. And you can equip your Comanche 230 with full instrumentation, multiple radio, automatic flight system, heated pilot, navigation beacon—the works—for less than the base price of any other aircraft of similar performance. But forget price. In the Comanche—180 or 230—you get a better, more useful, more comfortable airplane... bigger cabin, bigger luggage space, biggest useful load, by far! And you get a modern-new-jet airplane with the commanding eye appeal that makes you and your Comanche the center of attention whenever you fly.

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PIPER

AIRCRAFT CORPORATION
Lock Haven, Pennsylvania

ATTRACTIVE LEASE AND FINANCIAL PLANS AVAILABLE



CLOSEUP-BHE forging press rated at 30,000-ton capacity, will shape beryllium parts.

Beryllium Forging Process Developed

New York—Imposed durability requirements of beryllium resulting from a closed die forging process are reported to be the major reason that a heat sink and structural material for space vehicles.

Forging process, developed at the Wilmot Gender Co.'s USAF plant at North Chelmsford, Mass., produces large structural parts which require no machining or machining. Beryllium known for its high modulus of elasticity, high strength by weight ratio and heat sink capacity, has always been considered too brittle for large structural parts. Wilmot Gender reports, however, that its forgings have densities and isotropicity of the order of the strong aluminum alloys.

Test article component produced by means of the forging process was a 300-lb. aircraft heat sink.

Development of a successful forging process, in addition to increasing the metal's durability, presents value production of beryllium parts. Four pro-

Aerodynamicists

Join an expanding and progressive engineering environment where aerodynamicists see great personal responsibility, from Advanced Design support through Flight Test Analysis.

Openings exist for Flight Control Aerodynamicists, to perform stability derivatives and analyze feedback systems for both missiles and aircraft.

R&D activities centered in supersonic and hypersonic flow problems, orbital mechanics, microhydrodynamics, and reentry studies are central to insure about our programs for the future.

Write to: H. Reever

Engineering Personnel Manager, Box AWF 124
North American Aviation, Inc.
Columbus, Ohio

THE COLUMBUS DIVISION OF

NORTH AMERICAN AVIATION, INC.



Home of the T-33 Jet Trainer and the A-1 Vigilante

"GREATEST INVENTION SINCE THE WHEEL" **"ZIPPERTUBING"**

THE MODERN ECONOMICAL METHOD OF FRESHENING EXISTING CABLES!

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KAMAN HU2K-1



... nucleus for new helicopter concepts

Modern naval and military science has created the need for a helicopter of great flexibility. The routine requirements of performance, speed, range, endurance and load carrying ability have been extended to include computers, automatic navigation aids, all-weather operation and simplified service and maintenance.

In short, increasing requirements have created a helicopter of streamlined performance and characteristics, the Navy's HU2K-1. This ultra-modern helicopter is the nucleus of limitless possibilities and concepts in naval and military aviation. Features of the HU2K-1 include:

- "Free" gas turbine power
- High speed flight
- Automatic pilot and dead reckoning navigation
- Automatic stabilization equipment
- All-metal semi-rigid rotors
- In-flight rotor tracking
- "Fold-up" to minimum size in one minute
- Self-contained flotation equipment
- Electronic components accessible from within
- Easy maintenance and access to components

Pioneers in turbine powered helicopters... and new helicopter concepts.

THE **KAMAN AIRCRAFT CORPORATION • BLOOMFIELD, CONNECTICUT**
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duction methods required machining rough blocks under little or no pressure and subjecting the finished parts to long periods of heat treating. Tungsten, which can withstand temperatures up to 3,000° F., is the most common material used.

The tungsten insulator was developed at Wyocon-Gordon as part of a company funded research program. Details of the classified process were not disclosed. Wyocon-Gordon is investigating the possibility of patenting.

The company did reveal that medium-grain tungsten powder obtained from the Beryllium Corp. was forged in an 18,000-ton forging press. Oxidation is prevented by either a protective atmosphere or vacuum method.

WHAT'S NEW

Reports Available:

The following reports were sponsored by the Office of Technical Services, United States Department of Commerce, Washington 25, D. C.

A Proposed Methodology for the Strength-testing of Sup-Tite Alloys—by G. S. Ansel, Naval Research Laboratory, Gettysburg, 1933, \$5.00, 4 pages (PB 151047).

The Properties of Tungsten Carbide-Uranium Compacts of High Density and High Hardness—by P. A. Ryan and N. S. Ulrich, Watertown Arsenal Laboratories, U. S. Army, Watertown, 1953, \$1.50, 56 pages (PB 151048).

Investigation of a Method for the Measurement of Surface Conductivity, Viscosity, Surface Coefficient—by M. N. Abramson and P. A. Beltramini, Research Division, Institute for Wright Air Development Center, U. S. Air Force, Sacramento, 1957, \$1.25, 35 pages (PB 151049).

Design in Loft of a Not-to-Scale Configuration—by H. K. Chang, Cor nell Aeronautical Laboratory, Inc. for Wright Air Development Center, U. S. Air Force, Sacramento, 1957, \$1.25, 46 pages (PB 151050).

Incompressible Friction Factor, Transition and Hydrodynamic Resistance Length Studies of Disk with Trapezoidal and Rectangular Cross-Sections—by R. G. Eder and T. T. Ivan, Jr., University of Minnesota for Wright Air Development Center, USAF, April, 1957, \$0.25, 30 pages (PB 151071).

Chemical Resistance and Thermal Stability of Fluorocarbon Elastomers—by W. L. Wilson, C. B. Geiss, and J. C. Martinson, U. S. Army, December, 1957, 23 pages (PB 151042).

Chemelec*

STAND-OFF and FEED-THRU INSULATORS



A DEFENSE SYSTEM IS ONLY AS RELIABLE AS ITS SMALLEST COMPONENT

What better reason is there to choose Chemelec Stand-Off and Feed-Thru insulation? Reliability under any condition makes them ideal for missile guidance, fire control, tracking, and radar systems... nearly all critical electronic circuits. Durofilm® Teflon®—insulated for electronic applications—is used as the insulation body. Teflon has exceptional dielectric properties, is chemically inert, resists heat to ensure temperature won't breach under severe shock or vibration. And Chemelec Company's Quick-Set™ Stand-Off and Feed-Thru Insulators are designed for quick and easy installation and replacement without damage to supporting panel. You simply compress them into pre-drilled holes; they become self-locking, requiring no additional hardware for adjustment. Available in compression-mounted, metal-base, ceramic or cable-insulator types... standard B.M.A. colors with a wide range of sizes and terminal designs.

*Patented Technic, Shallow Testmark.

Chemelec® CONNECRES®—Teflon insulation for connecting high frequency services.

Chemelec insulation rods and feed-thru connectors are available in two thicknesses—approximately 0.010 and 0.015 inches. They are made of solid Teflon insulation and feature a built-in strain relief for added reliability to support high frequency connections. Chemelec Connectors come in sizes 1/4", 5/16", 3/8", 1/2", 9/16", 5/8", 11/16", 3/4", 7/8", 1-1/16", 1-1/8", 1-1/4", 1-1/2", 1-5/8", 1-3/4", 2-1/8", 2-3/4", 3-1/4", 4-1/4", 5-1/4", 6-1/4", 7-1/4", 8-1/4", 9-1/4", 10-1/4", 11-1/4", 12-1/4", 13-1/4", 14-1/4", 15-1/4", 16-1/4", 17-1/4", 18-1/4", 19-1/4", 20-1/4", 21-1/4", 22-1/4", 23-1/4", 24-1/4", 25-1/4", 26-1/4", 27-1/4", 28-1/4", 29-1/4", 30-1/4", 31-1/4", 32-1/4", 33-1/4", 34-1/4", 35-1/4", 36-1/4", 37-1/4", 38-1/4", 39-1/4", 40-1/4", 41-1/4", 42-1/4", 43-1/4", 44-1/4", 45-1/4", 46-1/4", 47-1/4", 48-1/4", 49-1/4", 50-1/4", 51-1/4", 52-1/4", 53-1/4", 54-1/4", 55-1/4", 56-1/4", 57-1/4", 58-1/4", 59-1/4", 60-1/4", 61-1/4", 62-1/4", 63-1/4", 64-1/4", 65-1/4", 66-1/4", 67-1/4", 68-1/4", 69-1/4", 70-1/4", 71-1/4", 72-1/4", 73-1/4", 74-1/4", 75-1/4", 76-1/4", 77-1/4", 78-1/4", 79-1/4", 80-1/4", 81-1/4", 82-1/4", 83-1/4", 84-1/4", 85-1/4", 86-1/4", 87-1/4", 88-1/4", 89-1/4", 90-1/4", 91-1/4", 92-1/4", 93-1/4", 94-1/4", 95-1/4", 96-1/4", 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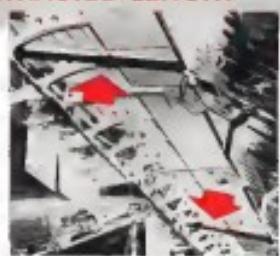
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General catalog for the year 1969 containing data sheet on Saginaw b/b Series and Systems... or see our section in General Product Catalogue.

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Bonne-Latour Corp., 18918 West Olympic Blvd., Los Angeles, Calif.

from the base, which has a standard steel bonded cover. Hand 475 is available in -6 (F-105) and in -8 (F-101) series.

Armco Corp., Jackson, Mich.



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Integrally lighted angle of attack indicator is approximately 30% lighter than former instrument manufactured by MIL-1 Electronics.

Instrument incorporates a three stage transversal cosa amplifier. A removable plate permits external adjustment of saturation points without disassembly of the instrument. Indicator may be clamp-mounted on a mast track mounted panel.

Melrose Division, Bendix Aviation Corp., South Melrose, Pa.



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Stainless steel safety relief valve handles gases, liquid oxygen and hydraulic fluids in remote applications.

Aero valve assists within 3 to 9.5 psi of set pressure to range from 50 to 15,000 psi in hydraulic, gaseous or cryogenic service. Safety valve is high pressure safety device to protect the bold when "Hold" button is held for 24 hrs. 24 hrs. of set pressure. Valve is made in stainless steel to resist corrosion.

Specialty Engineering Co., 264 W. Fairmount, San Gabriel, Calif.

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For details about these positions please contact Mr. A. D. Stevens, Director of Personnel, Young American Aviation, Dept. 100, Atwater, Calif.

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Radiation Research Corp., 1114 First Ave., New York 22, N.Y.



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Regulators adjust tension of North American X-15 control cables under varying temperature conditions. The diaphragm regulators are used on the pitch, roll and yaw power control actuators, and on the speed brake, rudder and fuel selector secondary actuators.

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Chance Vought Aims at Diversification

By Craig Lewis

Dallas-Sperreng by recent contract cancellation and backed by high cost rate levels, Chance Vought Aircraft Inc., is working hard to reshape itself as a more diversified company with a broader market base.

Given the past year or so, Chance Vought has taken a series of steps to reorganize and refocus management, seek greater diversification and new markets. These efforts were given new impetus when the Navy canceled the FMS-3 and Regulus II programs in December, but Chance Vought had been on the move long before these projects were lost.

Like other aircraft manufacturers, Chance Vought is faced with a rapidly changing military market in which highly complex systems are bought in small numbers and where generation of large production runs for a variety of military aircraft are rapidly becoming history.

Along with this general situation, Chance Vought has added a significant backlog of work from a single traditional customer—the Navy. Thus the company is working to broaden its activities within a new military market and to move into new markets.

Recently, the main focus of the Dallas-based corporation, Chance Vought had the bear rear in its history in 1958. Sales were \$313,702,412, up sharply from the \$230,392,110 figure for 1957 and margin after taxes rose from \$6,152,183 in 1957 to \$9,917,626 last year. The company distributed \$2,27,146 in dividends in 1958 and raised the sum with net working capital to \$37,581,574. Earnings amounted to \$7.15 per share.

Chance Vought's earnings of \$16,000,000 worth of convertible debentures still stand, but there also debenture holding \$8,814,000 in cash and, during the year, the company expanded its line of bank credit to \$54 million with borrowings totaling \$59 million at the end of December.

With this record for 1958, and with business continuing at a high level in 1959, Chance Vought is in good financial shape to support its diversification effort.

The only area where the company is poor shows a decline from the previous year in its backlog of orders. Backlog is down sharply from \$676 million at the end of 1957 to \$576 million at the end of last year, and that is when a good



CHANCE VOUGHT Aircraft's engine manufacturing facilities in Dallas will be modernized, each producing four compressor air jets for major strike aircraft as well as smaller jet engines for fighters. Above: Sixty Corsair fighters on the flight deck of the aircraft carrier USS Yorktown.

part of the damage from the carrier fire has been repaired and will be worth about \$17 million.

Both of the programs canceled would have added to production volume this year but, more important, they were advanced research systems with production lives which were likely to stretch beyond the Crusader fighter across into production. Employment dropped from an average level of 18,000 during 1958 to 17,700 a year and with the jobs handled in the last two weeks of December following the cancellation.

Another item rising from the production low this year is the Regulus I. This program was phased out in October, in December after Chance Vought had built 514 of the missiles. This leaves 1,959 business volume, all more than dependent on the Crusader series fighters—the FJU-1, the FJU-2, the FJU-2A fighter and photofighter, and the FJU-2B, an advanced version with limited all-weather capability.

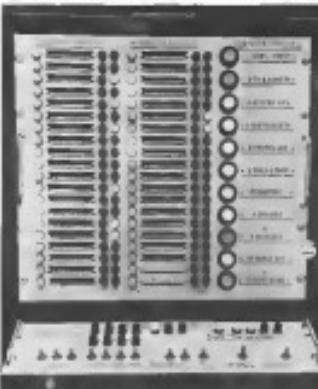
With the Crusader production now scheduled, Chance Vought can now focus on the second-line market in the fighter.

That means sales increases. Between last year's \$175 million and the \$275 million forecast in 1957, Crusader production is expected to last through 1964, although the production rate will be dropping as the fighter sales move toward obsolescence.

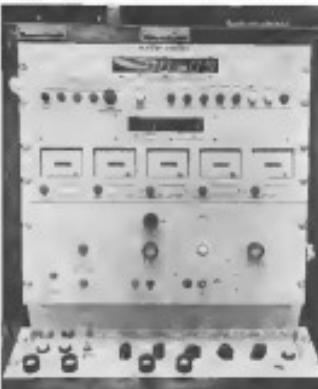
Chance Vought is working on pilot capsule and human factors aspects of the Delta Star program as a member of the Boeing Airplane Co team and this could furnish future business if the Air Force picks the Boeing team for the job. The company also has a subcontract to build tail sections for the North American B-70. This work is being

Concrete blockhouse at The Martin Co.'s Denver Division test facility for Titan intercontinental ballistic missile contains master operations control console (left), panel at left is fire water system control, case at extreme right is switch panel. At right is command center operator unit.

Operations Console Controls 200 Titan Functions



Close-up of baseline and system status panel (above, left) shows rated status, ranging from "low tank full" to "empty." Lights indicate status of the function. At right: the crusader time constant is shown as log window in rad. Second window indicates acceleration.



Master repository control operator (below, left) pushes in a controller on a monitor on the master repository program panel. About 200 functions can be checked. At right, console operator checks the error panel.



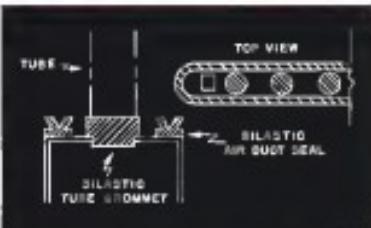
The PLANE

America's newest production member, the Convair B-58 Hustler. This delta-wing jet employs an area-ruled nose cone for supersonic range efficiency, and has reportedly been flown at speeds in excess of Mach 2 at 50,000 feet. Engines are four J-79's, in pods below the wings.



The PROBLEM

Sealing and cushioning various tubes in cooling air ducts for the B-58 Fire Control System, designed and produced by The Emerson Electric Manufacturing Company. Difficulties involved include heat—the sub-miniature tubes operate as high as 350°F—and severe cold when the units are inactive during flight. Protective material must stay resilient despite these extremes.



The PART

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in engineering, new, but testing and production will start to phase in late this year.

Charles Wright, President Fred O. Detweiler, Vice President Aviation Week has company assets to the Regulus II and F-105D contributions to much the same business that it had similar situations in the past. "We put a lot of people on the road looking for new business," he said, just as Charles Wright did in 1951 when the ASU 1 was canceled. At that time the company switched from subcontract work and engineering studies. Research and development work was increased and the engineering organization was built up.

After the 1954 cancellation, Charles Wright started working on defense feature programs and the reorganization late in 1955 added new experts in this program and accelerated future development in business planning. Detweiler said they took two or three years of consideration factor out of our future planning.

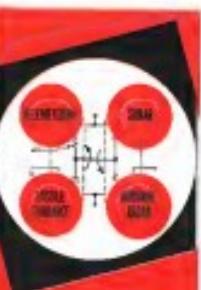
Shaping an Image

Charles Wright has been a separate corporation since it was spun off from United Aircraft in 1956, and the company has been steadily shaping a new, independent image for itself since then. This has amounted to a step by step maturation "to our own all the time," Detweiler said, and in recent the future is shaped a good deal in look of the firm's specialty as a supplier of New England aircraft and its derivative especially in the changing technology market of the past few years.

In 1955, operations were broken down under four vice presidents—aircraft, racing products, avionics and sales and service. Then in 1958, Clifford E. Bart was shifted from the job of vice president to controller to the top job of vice president finance. Late last year the division approved a new management organization in which Vice President Engineering, Raymond C. Blodgett, became vice president and general manager. Vice President Production George K. Johnson became vice president for business planning, sales and service. Vice President W. Paul Detweiler became vice president in charge of the Washington office and of aerospace.

With these changes, Charles Wright's top management is freed from everyday responsibility to concentrate on broad corporate interests and on the push for new business and new market areas.

Part of the search for new business lies in the increasing competitive subcontracting field. In the past Charles Wright has never had more than 10% of its sales in subcontracting and Detweiler doesn't expect it ever to go over that level. He said that subcontracting



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Most important requirement for these positions is versatility — that blending of education and experience which equips engineers to think in terms of hardware under field test conditions. An engineering degree and missile test experience are most desirable, but a sound background in related work can furnish the necessary qualifications. Specific requirements are as follows: **ELECTRONICS** (R.F. communication, instrumentation, servo control and guidance systems); **MECHANICAL ENGINEERING** (mechanics, hydraulics, propellant handling and loading, mechanized ground support equipment); and **CIVIL ENGINEERING** (establishment of design criteria on missile facilities). There are also outstanding opportunities for **ENGINEERS AND SCIENTISTS** in many other areas and at all levels for a variety of space programs under way at Convair-Astronautics' San Diego headquarters. Our engineering representatives will be conducting **INTERVIEWS** in these and other cities soon.

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will never be a major portion of sales. Bodner points out, however, that the defense of maintaining government contracts during wartime will determine what parts of your program are saved. His estimate does not include some participants such as Chance-Vought. Bodner's work is the 30% top estimate for subcontracting.

While management expansion has been shifting some changes have taken place in the company's technical organization which make it a trend toward product line grouping. An electronics department has been established to handle development work for Convair-Vought's current programs and to furnish support for its diversification into new fields. An anti-submarine warfare group has been set up to exploit that cold war potential. A major new group has been established to exploit Research experience and has been created to take over market stemming from work previously in the Pacific Missile Range and a new Army range at Ft. Huachuca. While these activities and others develop products for new business, they also furnish work for reliable technical personnel Convair-Vought wants to keep.

With that orientation toward product line grouping, one of these integrated groups could be lifted out of the present organization here and established in a separate operating division as new business should warrant such a move.

Broadened Market Sought

Convair-Vought has bid in various Navy Air Force and Army competitions in an effort to broaden its military market. Last year the company took the straightaway road of developing a missile with its own funds in a candidate for the Army's new basic air battlefield missile. Work was started in July, and test flights were made at Redstone Arsenal early this year. The missile is powered by an Aerojet solid rocket motor, rather than the Rocketdyne propellant reported earlier.

Convair-Vought built the missile with its own money to continue in bid because this was a first substantial sales effort with the Army, and the company wanted to make an impact beyond the usual bidding process.

Some congressional leaders in this considered desirable although the company has set no definite goals as distributor. Bodner told *Aerospace World* that "success is yet out" and Convair-Vought will find its way along in the game in the conventional field, arriving for whatever sort of sufficient commercial business develops.

Convair expects commercial business to be in keeping with the company's capabilities, and the more products which are truly complex internally. No consumer products are



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WHO'S WHERE

[Continued from page 23]

Changes

Robert F. Gollman, director of engineering and info. Sysop, Dynapac Co.'s Air Assessment Division, Great Neck, N.Y., has been appointed manager of Gen. E. Wright, former manager of the division; John R. Evans, supervising manager, Helder; Robert L. Windt, manager, sales and administration, Helder.

Charles E. O'Hollister, manager-open-loop planning and control, Systems Group, Inc., Santa Barbara, Calif.; Eugene M. Miller, manager supervisor of integrated development, McDonnell Aircraft Co.'s Douglas, Utah Division.

Jack Gray, senior contract administrator, Tonco Aircraft Corp., Dallas, Tex.; record record; Howard Clark, new business manager of the aircraft service program.

Kenneth D. Beaman, manager of the new producer of the Project Engineering Division and the West Coast affiliate, U.S. Flare, Inc., Atlanta, Ga., Okla.

Ernest F. Griswold, director of industrial engineering, Thompson Ramo Wooldridge, Inc., Cleveland, Ohio.

Robert T. McElroy, general sales manager, Korteks Aircraft Products Co., Inc., Detroit, Mich.

Albert W. Yahn, manager military transport sales, Canadian Lufthansa, Montreal, Quebec; Alan Donald W. H. Godfrey, assistant manager, administration, same.

Conrad R. Taylor, director manager of the Research, N.Y., office of the Microelectronics Division of Standard-Calcott, a division of General Dynamics Corp.

Arie J. Snyders, director of research and development, Chicago Division of U.S. Industries, Chicago, Ill.

U.S. Water Tunnel, manager of manufacturing, Data-Control Systems, Inc., Danbury, Conn.

John K. Wehrenbeck, chief Systems Engineering Division, Bell Telephone Laboratories, New York, N.Y.

James R. Becker, aviation sales manager, and Scott H. Marville, Jr., manager supply system engineering, Job & Huntz, Inc., Cleveland, Ohio.

John P. Donahue, chief engineer, Hydraulics Group, Allis-Chalmers Corp.

Col. Donald L. Petty (USA), test director of weapons development, Christy Lockheed, Anaheim, Los Angeles, Calif.

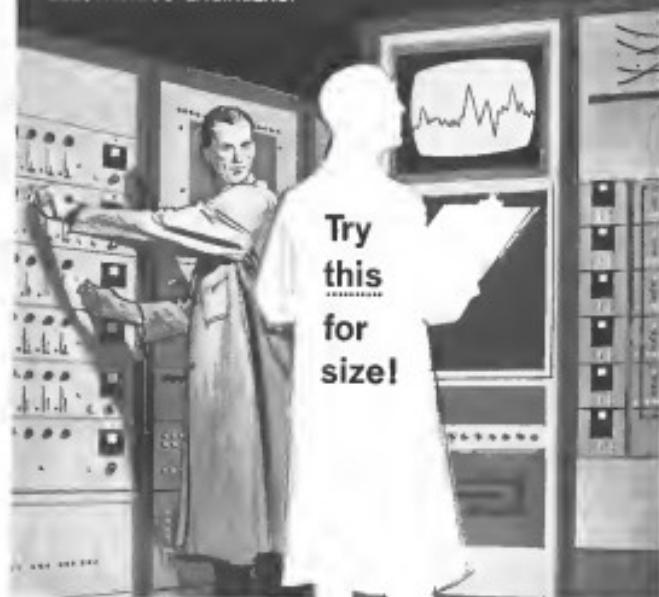
Hugh C. Brauer, manager State Barbers Division, Women's Design, a division of U.S. Industries, Inc., State Barber, Calif. and Denver, Colo.; James E. Johnson, William S. Dulay, project manager, underwater detection and identification systems programs, and development of special test equipment.

John F. Prochnow, corporate director of advertising, Pacific Aerospace Corp., San Francisco, Calif.

Miller R. Koenig, manager of reliability engineers and H.L. Connelly, purchasing agent, Taylor Products Division, Packard Bell Electronics Corp., Los Angeles.

De Vore F. Purcell, manager environmental, Electronic Defense Laboratory, Bell Communications Research, Inc., Mountain View, Calif.

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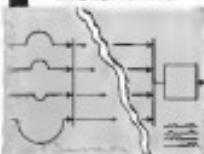
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Some News of Moment to Engineers

and Scientists who have participated in Operations Research & Systems Analysis—from Computer Department of General Electric

IN WASHINGTON, D.C. NEXT WEEK—

in coming weeks, a group of men—when the engineering world is beginning to call "wise the geniuses"—will sit around a table with representatives of the Air Force, defining the problems and formulating the conceptual basis of an unprecedented DATA PROCESSING SYSTEM. This system will handle collection and distribution of continuing variables in a real time basis before accepted and transposed present potential in Man-Machine Relationships.

These men are drawn from many disciplines—mathematics, psychology, computer and system engineering, philosophy, communications. In essence, they have three attributes: unusual abilities to listen, synthesize, communicate, collaborate, and take a broad, all-encompassing view of multiple problems.

The program, initiated early in 1968, is being conducted for the Air Force by General Electric's Computer Dept., from its Washington, D.C. office and headquarters in Phoenix, Arizona.

CONCURRENTLY, SUPPORTING TEAMS OF SPECIALISTS ARE ENGAGED IN INTENSIVE RESEARCH. As a result, previous constraints limiting extremely high-volume, high-speed information storage and retrieval performance are disappearing. Major breakthroughs in computer concepts and technology are moving rapidly into the realm of the possible.

STEADY STAFF EXPANSION

in both Phoenix and Washington, D.C. has created a number of openings for specialists—from the "aspirant generalist" to the engineer with 3 to 5 years' experience in the computer field.

YOU ARE INVITED TO INQUIRE ABOUT THE FOLLOWING ASSIGNMENTS:

INFORMATION SYSTEMS ANALYSIS (Input Concepts) PhD preferred •

HUMAN FACTORS ANALYST & TRAINER PhD, MS • SYSTEMS INTEGRATION • COMMUNICATIONS ANALYSIS (Demilitarized Control) •

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Write, in confidence, to Mr. T. E. Terrell, Div. 64-V-N.

COMPUTER DEPARTMENT

GENERAL ELECTRIC

15420 N. 56th, Capri Highway, R.D. Box 273, Phoenix, Arizona



AVIATION WEEK, April 6, 1968

LETTERS

Improved Defense

I enjoyed your recent editorial ("The Defense Budget," AW, Feb. 12) and it is also cause to me of a way to improve defense rapidly with no change in the money allocated, no change in any one company's share of the defense dollar, and the largest share of all no major political involvement.

Given the Title III of my amendment to the AFSC, title 49 of the Title I GOMR money and put it on Defense. Since Martin is one of the prime contractors on this program and they are doing well, Title III would be the best of the Defense budget to use of the work already done on Title III will be wasted and Martin was a large user of the defense dollars they now control. There are many more reasons this looks good, such as the Air Force will know its users and can better coordinate with them and other contractors in their planning, which seems rather odd compared to the fact we would lose AFSCM representation in the next two years and Downsize will be addressed as well as the rate of pilots received were our active pilots not considered as congressional pilots representing the Senate and a naturally satisfactory contract has been negotiated.

Airman Well addresses the opinions of its readers on the names related to the magazine's editorial columns. Address letters to the editor, Airman, 200 E. 42nd St., New York 17, N.Y. Try to keep letters under 500 words and give a genuine identification. We will not enter anonymous letters, but names of writers will be withheld on request.

Respectfully yours, —
John C. Tamm, Jr.
Chairman, AFSCM
Senate Armed Services Committee

Washington, D.C. 20510

Editor, Airman

Editorial Column

ESNA LH3393 (220,000 psi)	.44	.77	1.20	1.69	2.55
COMPETITIVE Lightest Nut (180,000 psi)	.60	1.00	1.50	2.15	2.82
COMPETITIVE Lightest Nut (220,000 psi)	.95	1.62	2.75	4.25	6.00

Tomorrow's hypersonic airframes must withstand flight stresses and related vibration conditions that would have seemed insurmountable even five years ago. Yet to achieve such speeds these aircraft will have to utilize lighter-weight structural components than their subsonic predecessors.

ESNA Type LH3393 double hex, external wrenching nut now offers the designer of tomorrow's airframes and missiles a structural fastener with the highest strength-to-weight ratio of any currently available self-locking nut.

Design refinements embodied in the LH3393 series consistently develop the full fatigue strength of 220,000 psi high strength bolts . . . yet these nuts are from 10% to 33% lighter, size for size, than even the lightest 180,000 psi locknut.

Additional weight savings are made possible by the smaller envelope dimensions of these new parts, since reduction of wrench clearance requirements permits reductions in the size of other structural components.

LH3393 series nuts are cold-formed from alloy steel, processed with the manufacturing skills and protected by the rigid quality control established during ESNA's 30 years of experience in supplying dependable aircraft quality fasteners. The same military approved, ELLIP-TITE locking device used on ESNA's complete line of NAS parts, assures reliable vibration proof self-locking performance at temperatures up to 550°F.

For specific dimensional, design and test data on ESNA's new, lightweight, 220,000 psi nut-Type LH3393, write to Dept. S23-425, Elastic Stop Nut Corporation of America, 2330 Vauxhall Road, Union, New Jersey.



**ELASTIC STOP NUT
CORPORATION OF AMERICA**

*U.S. Patent No. 2,588,372